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THE LABORATORY PREPARATION OF ZINC DIETHYL AND LEAD TETRAETHYL.

By MARTIN MEYER.

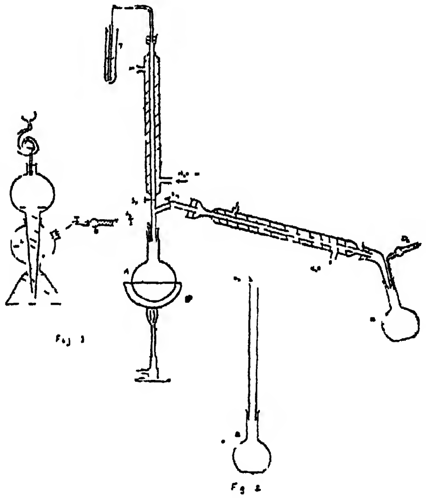
(Contribution from the Baskerville Chemical Laboratory of the College of the City of New York.)

Lead tetraethyl is a compound that has developed some interest and importance in the last few years. Although it was discovered by Lowig in 1853, it attracted no attention until Midgely proposed its use as an addition to motor fuels. Since then, and especially in the last five years, some notice has been paid to it and its commercial use has been steadily increasing, until recent fatalities in connection with its manufacture put a momentary check to its progress. In this relation, the writer had occasion to investigate its properties, and, therefore, found it necessary to prepare considerable quantities of it. A search of the literature disclosed that alkyl lead compounds had been prepared by two general methods:—

1. The action of lead chloride on zinc diethyl or on magnesium ethyl iodide. For example:—
$$2PbCl_2 + 4Zn(C_2H_5)_2 = Pb(C_2H_5)_4 + 4Zn(C_2H_5)Cl + Pb.$$
2. The action of alkyl iodides or bromides on sodium-lead alloy. For example:—
$$6C_2H_5I + (Pb + 6Na) = Pb_2(C_2H_5)_6 + 6NaI$$

The second method, or rather the variation of it, has been patented (Brit. Pat. 214,221, Apr. 13, 1924, C. A. Kraus and C. C. Collis, Standard Development Co.), and is useful as a commercial one, but after some experiment, the first was chosen as the simplest from the laboratory standpoint.

The preparation of zinc diethyl is given by Vannino (*Präparativ Chemie*, page 311), as adapted from the method of Simonowitsch (*J. Physch. Ges* 31, 38), and that of lead tetraethyl from it, by Frankland and Lawrence (*J. Chem. Soc.*, XXXV., 245, 1879). Both of these methods of synthesis were employed and after some experiment the following modified methods, which it is believed are simpler and smoother, were developed.



EXPERIMENTAL.

1. The Preparation of Zinc Diethyl.

The apparatus is set up as in Fig I. With a few comments, the diagram is self-explanatory. Good soft rubber stoppers may be used throughout, and indeed, are preferable to corks. D_1 and D_2 are calcium chloride drying tubes. S_1, S_2, S_3, and S_4 are stopcocks. The outlet tube of S_2 and S_4 nearest to flask A should, for obvious reasons, slant toward the flask and not away from it. S_1 should be as near the bend as is practicable.

Approximately 200 grams of pure zinc dust and 20—30 grams of granulated zinc are charged into flask A, which should be

of highest grade Pyrex, and of about 500 c.c. capacity. Stopcock S_3 is closed, stopcocks S_1, S_2, and S_4 are opened, and flask B, also of about 500 c.c. capacity, is removed. Flask A is heated gently with a small Bunsen flame for about half an hour or until no more moisture is distilled out of it, while a slow stream of CO_2 passes through the apparatus. Toward the end the zinc dust should be moderately strongly heated and then allowed to cool in an atmosphere of CO_2.

Now replace B in its proper position and see that the test-tube T contains about two inches of mercury above the surface of the outlet tube. Add 200 grams of ethyl iodide (Sp Gr. 1.9) which has been dried over calcium chloride for 24 hours, to A. Place a water bath in position under A as shown in the diagram. Close stopcock S_1 and open S_3. Allow a stream of CO_2 to flow through for five minutes and then close S_1 and S_2. Warm the water bath to 80° C. for about two hours and eventually raise to 96° C. When the reaction is complete no more ethyl iodide will condense in the reflux condenser.

Should the reaction fail to start, as occasionally happens, it may be necessary to distil all of the ethyl iodide over into B and reheat the zinc for a few minutes Once is usually enough.

When the reaction is ended, the water bath is removed and the apparatus allowed to cool to room temperature. S_3 is then closed, S_1 opened, the water bath is replaced by an oil bath, and a stream of CO_2 is passed through for another five minutes. Close S_1 and S_3 and distil the zinc diethyl into B by carefully heating the bath. This careful procedure is necessary, for zinc diethyl catches fire spontaneously in the air, and even small amounts of air in the apparatus are quite likely to cause difficulties, if not danger, owing to the clogging up of the stopcocks with zinc oxide which is formed.

The yield is nearly quantitative in accordance with the equation:—

$$2Zn + 2C_2H_5)_2 + ZnI_2$$

Zinc diethyl is a colourless liquid of Sp. Gr. of 1,182 at 18° C., boiling at 118° C.

2. The Preparation of Lead Tetraethyl.

Flask B is removed from the train and quickly stoppered. Approximately twice the molecular quantity of zinc diethyl, of lead chloride is carefully melted, heated for a few minutes, and then allowed to solidify with stirring in an evaporating dish, to prevent caking. Then it is finely powdered in a mortar.

Flask B is placed in a deep beaker filled with CO_2. A two foot, wide bored piece of glass tubing equipped with a cork to fit B is filled with CO_2 and quickly attached to B as shown in Fig 2.

The flask is then removed from the beaker and the lead chloride is slowly added with shaking through the wide tube. If the flask becomes warm to the touch it should be cooled by placing in water. When the reaction is complete as is shown by no more white fumes rising into the tube, it is allowed to stand for one hour. Then the reaction mixture is decomposed by the careful addition of cold water, adding small portions at a time and shaking between additions.

The final mixture is distilled with steam. The receiver should be closed and equipped with an outlet tube, to maintain atmospheric pressure and allow the escape of vapours, which leads directly to a hood or vent.

Lead tetraethyl is a colourless liquid of Sp. Gr. 1.62. It may be dried over calcium chloride and filtered to remove suspended impurities It may also be distilled under diminished pressure, but is liable to decompose with explosive violence as the pressure rises. The boiling point is below 200° C. under diminished pressure.

The yield is 90% as calculated from the equation:—

$$2PbCl_2 + 4Zn(C_2H_5)_2 = Pb(C_2H_5)_4 + 4Zn(C_2H_5)Cl + Pb$$

Summary.

1. A simple method for the preparation of lead tetraethyl in the laboratory has been given.

2. The properties of this compound have been and are being investigated, but these results are not available for publication.

December, 1924.

ARGENTINE IMPORTS IN 1924.

The British Commercial Secretary at Buenos Aires reports that, according to advance figures furnished by the National Statistical Department, the import trade in 1924 amounted in value to £147,181,000. The shares of the principal contributing countries are as follows:—The United Kingdom, £34,393,000; the United States, £32,443,000; Germany, £18,410,000; Italy, £12,573,000; France, £9,787,000; and Belgium, £7,849,000.

THE STRUCTURE OF STRONTIUM.

By HAWKSWORTH COLLINS, B.A., Camb.

The constitution of strontium was given in *The Chemical News*, 1920, CXXI., 222, as CaTi for chemical and mineralogical reasons. This will now be proved to be correct quite independently by means of the laws of relative volume and heat of formation.

TABLE I.

(1)	Sr(88)	=	Ca(40)	+	Ti(48)
(2)	35.1	=	25.66	+	9.41
(3)	30.68	=	25.66	+	5.02
(4)	23.98	=	14.54	+	9.44
(5)	19.56	=	14.54	+	5.02
(6)	25.31				

These volumes and part-volumes are similar to those of Ba (*The Chemical News*, 1925, CXXX., 307), and therefore contain truth on the face of them independently of the exact confirmations which follow.

TABLE II.

	Relative Volume.	Theor S.G. 15° C.	Obs. S.G.	...
(7)	Sr 35.1	2.507	2.504	Matthiessen
(8)	Ca 25.66	1.56	1.566	Matthiessen
			1.55	John
(9)	TiO_2 9.41 + 7.53 + 2.51	4.1	4.1	Hautefeuille
(10)	$MgO.\ TiO_2$ 8.71 + 2.51 + 9.44 + 7.53 + 2.51	3.91	3.91	Hautefeuille
(11)	MgO 8.71 + 2.51.	3 565	3 5699	0° Ditte
(12)	Sr 30.68 (see Table III.)			
(13)	$SrCl_2$ 23.98 + 2(15.085)	2.94	2.960	Filhol
			2.8033	Karsten
(14)	$SrBr_2$ 23.98 + 2(18.06)	4.14	3.962	12° Bodeker
		4.216	24°4	Nostrand
(15)	SrB_6 23.98 + 6(3.85)	3 28	3.28	15° Nostrand
(16)	CB_6 8 + 6(3.85)	2.51	2.51	Nostrand
(17)	SrC_2 23.98 + 2(5.69)	3 17	3.19	Nostrand
(18)	SiC 7.13 + 5.69	3.12	3 12	15° Nostrand.
(19)	$MnSi$ 6.94 + 7.13	5 90	5 90	15° Nostrand
(20)	$MnSi_2$ 6.94 + 2(7.13)	5 24	5.24	13° Nostrand
(21)	$CaCl_2$ 11.51 + 2(15.085)	2 48	2,480	Playfair and J.
(22)	SrO 23 98 + 2.51	3.93	3 9321	Karsten
(23)	SrO 19.56 + 2.51	4.71	4.750	Brugelmann
			4.611	Filhol
(24)	$SrCO_3$ 19.56 + 8 + 7.53 + 2(2.51)	3,69	3 68 – 3.714	Dana
(25)	$SrBr_2.6H_2O$ 19.56 + 2(23.09) + 6(14.03)	2.36	2 358	18° Favre and V.
(26)	$SrCl_2.6H_2O$ 19.56 + 2(15.085) + 6(14.03)	2.0	2.015	Playfair and J.
			1.964	Mahlberg
(27)	SrI_2 19.56 + 2(27.75)	4 556	4.55	25°/4 Nostrand
(28)	$SrHPO_4$ 19.56 + 5.76 + 26.54	3 518	3.541	15° Nostrand
(29)	$Ca_5(PO_4)_3F$ 5(14.54) + 3(26.54) + 5 42	3.2	3.166 – 3.235	Rose
(30)	$SrCl_2$ 25.31 + 2(15.085)	2 86	2.8033	Karsten
			2.96	Filhol
(31)	$SrCl_2\ 6H_2O$ 25.31 + 2(15.085) + 6(14.03)	1.912	1.921	Buignet
(32)	$SrBr_2$ 25.31 + 2(18.06)	4 04	3.985	20°.5 Favre
			4.216	24°/4 Nostrand
(33)	SrN_2O_6 25.31 + 2(3.8) + 6(7.53)	2.71	2,704	Playfair
(34)	$SrN_2O_6.4H_2O$ 25.31 + 2(3.8) + 6(7.53) + 4(14.03)	2.116	2.113	Filhol

(35)	SrN_2O_6 23.98 + 2(3.8) + 6(7.53)	2.76	2.805	Buignet
			2.704	Playfair and J.
(36)	SrN_2O_6 10.56 + 2(3.8) + 6(7.53)	2.93	2.947	Le Blanc

These results can only be fully appreciated by a study of all the hundreds of other similar and exact results which have been published in *The Chemical News* from January 20, 1924, onwards.

TABLE III.

	Heat of Formation of Sr.							Original Volume		Rel. Vol. in combination		Change of Volume
(37)	70752	=	120	×	6.7	×	88	30.68	=	23.98	+	6.7
(38)	56725	=	120	×	5.37	×	88	30.68	=	25.31	+	5.37
(39)	aq. 67950											

TABLE IV.

	Heat of Formation.		Theor.	Obs.	
(40)	Sr. Cl_2 70752 + 2(56786)	=	184324	184500	184700
	corresponds with No. 13)				
(41)	aq. Sr. Cl_2 67950 + 2(63870)	=	195690	195690	195840
(42)	aq. Sr. Br_2 67950 + 2(52930)	=	173810	173810	174210
(43)	Sr. C. O_3 70752 − 13886 + 32341 + 2(96155)	=	281517	281400	
(44)	aq. Sr. I_2 67950 + 2(37720)	=	143390	143460	
(45)	Sr. O 56725 + 71515	=	128240	128410 T.	131200
(46)	Sr. $O_2.H_2$ 56725 + 71515 + 117460 − 2(15300)	=	215100	217300	
(47)	aq. $Sr.O_2.H_2$ 67950 + 71515 + 117460 − 2(15300)	=	226325	226140 T.	
(48)	aq. $Sr.O.N_2O_5$ 67950 + 32341 + 85332	=	185623	185410	
(49)	$Sr.O_2.N_2O_4$ 70752 + 2(32341) + 85332	=	220766	222470	
(50)	aq.$Sr.O_2.N_2O_4$ 67950 + 2(32341) + 85332	=	217964	217850	
(51)	$Sr.N_2.O_6$ 70752 −2(23300) + 6(32341)	=	218198	219900	
	corresponds with No. 35)				
(52)	aq.$Sr.N_2.O_6$ 67950 − 2(23300) + 6(32341)	=	215396	215280	
(53)	aq. H_2 Cl_2 − 2(24350) + 2(63870)	=	79040	78360 T.	
(54)	liq. $H_2.O$ − 2(24350) + 117460	=	68760	68360 Thomsen	
				69000 Berthelot	

HEAT OF NEUTRALISATION.

When (53) and 45) produce (54) and (41), the changes that occur are:—

56725 becomes 67950
71515 becomes 117460

(55) 67950 − 56725 + 117460 − 71515 = 57170 56970 T.

HEAT OF HYDRATION.

When (54) and (45) produce (46) the only change is: —

− 2(24350) becomes − 2(15300)

(56) 2(24350) − 2(15300) = 18100 17700 T.

HEAT OF NEUTRALISATION.

When (53) and (46) produce (41) and twice (54), the changes involved are:—

71515 becomes 117460
2(−15300) becomes 2(−24350)
56725 becomes 67950

(57) 117460 − 71515 − 2(24350) + 2(15300) + 67950 − 56725 = 39070 39270 T.

HEAT OF SOLUTION.

When (46) produces (47) the only change is:—

56725 becomes 67950

(58) 67950 − 56725 = 11225 11610 T.

HEAT OF NEUTRALISATION.

When (53) and (17) produce (41) and twice (54), the changes are:—

71515 becomes 117460

− 2(15300) becomes − 2(24350)

(59) 117460 − 71515 − 2(24350) + 2(15300) = 27845 27630 T.

HEAT OF ELECTROLYSIS.

Thomsen found by depositing Sr electrolytically that

(Sr: 2HCl aq) = 117050

The two H-atoms go off to their original zero state, thereby evolving 2(24350) calories; and Sr comes from its zero state of rel. vol. 30.68 to its aqueous volume; (53) being concerned in producing (41).

(60) 2(24350) + 67950 = 116650 117050 T.

HEAT OF SOLUTION.

When (45) and (51) produce (47),

56725 becomes 67950

2(−24350) becomes 2(−15300)

(61) 67950 − 56725 − 2(15300) + 2(24350) = 29325 29340 T.

TABLE V.

	Magnetic Rotation.		Theor.	Obs.	
(62)	$SrCl_2$ 1.836 + 2(3.932)	=	9.7	9.7	Perkin
	(corresponds with Nos. 13 and 40)				
(63)	$SrBr_2$ 2.25 + 2(7.95)	=	18.15	18.16	Perkin
	(corresponds with No. 25)				

Half the atomic weight divided by 23.98 = 1.836

Half the atomic weight divided by 19.56 = 2.25

The Law of Magnetic Rotation was demonstrated in full in *The Chemical News*, 1923, CXXVI., 197.

Evidence from Mineralogy that Sr = CaTi

(64) Titanite, an oxide of Ca, Ti, Si, occurs in syenite at Strontian in Argyleshire. This is the locality from which strontianite ($SrCO_3$) is obtained.

The volume 30.68 is exactly correct for three independent reasons:—

(A) It can be split up (No. 3) into two parts, which have been shown to be volumes respectively of Ca and Ti both here and in the paper on barium (*Chemical News*, 1925, CXXX., 307).

(B) It is found (No. 37) to be the original volume of the element by means of the H.F. 70752, which occurs 4 times in Table IV.

(C) It is also found (No. 38) to be the orig. vol. by means of the H F 56725, which occurs 6 times in Table IV. *et. seq.*

The volume 23.98 is exactly correct for 9 independent reasons:—

(A1) It can be split up (No. 4) into two parts which have been shown to be volumes of Ca and Ti;

(A2—A7) It occurs 6 times in Table II. Each experimental determination of S.G. is absolutely independent of all others.

(A8) It requires the same original volume as the other (No. 38) by the law of H.F.

(A9) It satisfies the law of magnetic rotation exactly (Table V.)

The volume 19.56 is also exactly correct for 9 independent reasons.

(B1) It can be split up (No. 5) into two parts which have been shown to be volumes of Ca and Ti.

(B2—B8) It occurs 7 times in Table II.
(B9) It satisfies the law of magnetic rotation.

SUMMARY.

64 experimental facts obtained by scientists who are or were experts in their several domains, are here given, together with about the same number of deductions, which are evidently correct. Each one of these deductions leads up to the definite conclusion that an atom of Sr has been formed by the union of one atom of Ca with one of Ti.

The only experimental datum required in order to make the matter complete is that an atom of Sr may have a relative volume of 30.68 in the free state, *i.e.*, that it may have a specific gravity of 2.868 ($= 88 \div 30.68$), especially when it is deposited electrolytically from $SrCl_2$.

In order to be certain of this, an experimentalist would have to be quite sure that the element does not absorb heat from surrounding objects after deposition so as to reach the volume 35.1 given in No. 7.

In addition to demonstrating the structure of Sr by means of four sets of experimental data, *viz.*, At. wt., S.G., H.F. and M.R., this paper accomplishes the following objects: —

(C1) It continues the reduction of the experimental data of S.G. to exact instruments of research.
(C2) It strengthens the Law of Relative Volume.
(C3) It strengthens the Law of Heat of Formation.
(C4) It demonstrates the causes of Thomsen's observed experimental effects, not necessarily of his calculated effects.
(C5) It strengthens the Law of Magnetic Rotation.
(C6) It continues the demonstration of the Co-relationship of Physico-Chemical Constants.

VALUE OF INDUSTRIAL RESEARCH.

U.S.A. BUREAU OF STANDARDS VISITING COMMITTEE PUTS EMPHASIS ON BASIC RESEARCH.

Cites examples of its value in the past; believes more to come in future. Industrial research also held essential to prosperity.

The value of basic research, aimed at the acquisition of knowledge without immediate utilitarian objectives, was emphasised in the report of the Visiting Committee of the Bureau of Standards (Dept. of Commerce, Washington, D.C., U.S.A.). The committee expressed the belief that such work should be undertaken by the Bureau to a greater extent than has been done in recent years.

"The history of civilisation is filled with illustrations of the utilisation for the good of humanity of the results of scientific work, undertaken without reference to its direct value, and often remaining unused long after its first announcement," the report states. Illustrations given are the electrical industry, radio, the vacuum tube, X-rays, and radium. In each case the fundamental discoveries that made invention possible were made without thought of possible utility. Similarly, the present day study of atomic physics is cited as a line of research that is likely in the future to yield results of vast proportions, and as yet undreamed of.

The report also calls attention to the value of industrial research—a value more generally realised. Numerous examples of savings effected by such research at the Bureau of Standards are given. Studies of certain problems pertaining to the automobile industry are cited, whose combined result is a saving of $155,000,000 per year to the American public.

Both types of research, the committee believes, are essential to the welfare and industrial prosperity of the nation. The economies resulting from them are often very considerable, and are necessary if America is to maintain its present high wage rates and high standards of living in the era of intense industrial competition upon which the world now appears to be entering.

The desirability of having research conducted by a national institution is emphasised. Its value depends on the extent to which the results are utilised rather than upon the cost of the work, and a national laboratory such as the Bureau of Standards can afford to give its results freely to all who can profit by them, whereas a private laboratory cannot always be expected to do so.

The Visiting Committee is composed of Dr. Wilder, Dr. Barecroft, Corwell University, Ithaca, N.Y., Mr. Gano Dunn, N.Y., U.S.A., Dr. William F. Durand, Brooklyn, N.Y., Dr. Samuel W. Stratton, Massachusetts Institute of Technology, and Mr. Ambrose Swasey, Cleveland, Ohio. The

Board of Visitors have issued a very interesting report. Incidentally, it is noted that the Bureau of Standards is being carried on in accord with the organic aid of Congress, which gives it the custody of National Standards of Science and Industry, invests it with the function of comparing such standards with like standards used in scientific research, industry, commerce, and education, with the duplication or multiplication of such secondary standards with the testing and calibration of measuring apparatus; with the solution of problems which arise in connection with standards and with the determination of physical constants and properties of materials. The report deals with the wide range of the activities of the Bureau, and is convincing evidence of the extremely useful work in which it is engaged.

PULVERISED FUEL.

The Latest Developments Considered along with Low Temperature Carbonisation, in Relation to the Mining Industries.

By David Brownlie. B.Sc. (Hons.) Lond., F.C.S., M.I.Chem.E., A.M.I.Min.E., etc.

Read before the Manchester Geological and Mining Society, on May 12, 1925.

(*Continued from Page 390.*)

The subject of pulverised fuel firing is such an enormous one that it is always extremely difficult to give a broad survey of the facts within any reasonable amount of space. However, in conjunction with the new plants already described, a discussion of the following items will fairly well cover the ground as regards the very latest developments.

Drying.

A very considerable revolution has taken place during the last year or two in connection with the drying of the coal before pulverising. In the old days, down to 1% moisture was regarded as essential, but this is now known to be entirely unnecessary. In general, all that is required is the removal of what may be termed the added or mechanical, moisture, as distinct from the natural moisture in the coal itself, and, of course, that obtained by chemical decomposition of the coal substance. Roughly speaking, average figures to-day at 9-12% moisture in the coal as received, which is dried down to, say, 3-5%, and the only difference in a modern type of mill as compared as coal 1% moisture is a very slight lowering of the output. It was the added, or mechanical moisture only that caused the trouble in the way of great reduction in capacity and increase of power, which resulted in the opinion that all moisture ought to be got rid of.

Thus, for example, as the result of most detailed investigations carried on at the smaller Brunot Island power station of the Duquesne Light Company, at Pittsburg, before the installation of this method of firing at the much larger Colfax station, local coal containing up to 5-6% moisture was pulverised and used without difficulty, the only trouble being a slight reduction in the capacity of the pulverisers.

In this case a good quality run of mine coal from an adjoining pit was used, having the average analysis of fixed carbon (dry basis) 56.0%, volatile matter (dry basis) 33.0%, and ash (dry basis) 11.0% with 3.5% moisture, 1.5% sulphur, and a heating value of 13.500 B.Th.U. (dry basis). Very often the moisture figure went up to 5-6%, but, as already indicated, no dryers are used.

As regards the plant for carrying out the drying operation, the long horizontal or slightly inclined separately fired cylindrical dryer revolving at a slow speed of about 3-1 revolution per minute, is now beginning to be regarded as obsolete, at any rate so far as steam generation is concerned. The modern principle is the small vertical self-contained continuous gravity dryer situated between the overhead crushed coal bunker and the pulveriser mill below, forming a neat and efficient combination. The rotary apparatus has the disadvantages of being enormous in size, especially as regards length, and occupies a very large amount of valuable space, approximately 40 cubic feet per ton of coal dried, whilst the capital cost is heavy and the labour and attendance considerable. Also the total nett power necessary for operation is somewhat excessive, approximately equivalent to 1% of the coal burnt, the fan for drawing the heated air through having to be about 1.000 cubic feet of air per minute per ton of coal dried. Further, the continual churning up and agitating of the coal creates a very dusty atmosphere, increasing the risk of fires and nearly all caused, directly or indirectly, by explosion, which in the early days were the dryers.

Also, the rotary dryer is not particularly efficient from the point of view of heat

transmission, as with all cylindrical apparatus of this character, whether for drying, carbonising coal, and other material, or in various chemical operations, such as cement manufacture. The heated air naturally always tends to pass right through the cylinder above the coal or other material, whilst methods to try and increase the contact are extremely complicated, and result in much increased power consumption.

The modern vertical gravity coal dryer on the "Wood" principle was operated experimentally at the Oneida St. Station of the Milwaukee Electric Light and Power Company for the two years 1921-1922, and the first large installation was that at the Cahokia station, St. Louis, as already indicated, whilst to-day the principle is in operation or being installed in a large number of the most up-to-date boiler plants in the world, such as the Cleveland, Trenton Channel, and many other stations in the United States, Vitry and Gennevilliers in Paris, and Willesden, St. Pancras, Birmingham, and Derby in Great Britain. As is well-known, the design consists in the use of a comparatively small vertical cylinder placed between the crushed coal bunker and the pulveriser containing inside two louvred pipes or narrow diameter cylinders, the coal passing downwards by gravity as taken away by the pulverisers underneath.

Part of the hot exit chimney gases, roughly about 10% of the total equal to 3 lbs. of gas and air, 1.0 lb. coal, are taken by means of a fan and suitable trunking, the arrangement being illustrated clearly in Fig. (1), generally mixed with air to give a temperature of about 215° F., and circulated continuously through the dryer back to the chimney again. The total power required is only about 3 K.W. per ton of coal, say, equal to 0.15% of the steam production of the plant. The design has been proved to be extremely effective, being simple and efficient, occupying practically no space of importance, whilst the labour is negligible. The heating surface is the extremely small figure of about 25-35 square feet per ton of coal per hour. As regards the temperature of the air and flue gas mixture, it now seems to be regarded as the best practice to have a figure of 250°-400° F. entering the bottom of the dryer, with 150° F., leaving at the top, the cold air supply damper being adjusted to give a final exhaust gas temperature of 25°-50° F. higher than the dew point. It is apparently not necessary in many cases to have the exhaust temperature as high as 212° F., as hitherto considered essential, and 150° F. is quite sufficient provided the gases are not saturated and there is no danger of re-deposition of the moisture at any stage of the drying.

The very latest development of the continuous vertical gravity dryer is the use of air combined with exhaust steam heaters instead of air mixed with hot flue gas. These steam heaters are on the lines of the ordinary gilled steam radiator and are placed in the vertical drying cylinder, whilst there is passed through them inside low pressure steam, either the exhaust of any convenient steam driven auxiliary plant or "bled" specially from the turbine. The hot condensed water is returned to the boiler plant so that the dryer really functions as a condenser in which the heat is usefully employed in drying coal instead of being lost in the cooling water. In this new type of dryer, about 30 square feet of heating surface per ton of coal per hour is required for every 1% moisture, whilst the amount of air passing through is about 1/3 that of the air and waste heat dryer, that is 1 lb. of air per 1 lb. of coal. This is because the air from the boiler house is moderately dry and does not contain already a large amount of moisture, as in the case of hot flue gases.

Other minor advantages of this design are that the fire risk is nil, although almost negligible with the waste heat dryer, whilst the amount of coal lost as dust is approximately 0.01% with the air and exhaust steam dryer instead of 0.1-0.25% with waste heat.

Pulverising.

The main developments in pulverising during the last year are in the first place that it is not now regarded as necessary to dry the coal to excess, as already discussed in detail. The standard mill is practically the vertical, centrifugal, completely-enclosed roller type, with 4-6 rolls, having a continuous gravity separation of the pulverised fuel by means of a current of air. The power used varies between 9.5-18.0 K.W. per ton, depending on the character of the coal, which is, of course, very important, and the general operation, including the items of wear and tear, maintenance and cost of upkeep, is very satisfactory.

Another important point is that excessively fine grinding, such as 65% through a 200-mesh is now shown to be unnecessary, provided that uniform particles are obtained, say 95% through 100 mesh. The ideal would be 100% through 100-mesh, and

it is no use having a large part of the fuel pulverised to excess if a number of large particles are contained in it. Roughly speaking, however, with modern mills and average fuel, 90% through a 100-mesh is equal to all through 50-mesh and 70% through 200-mesh.

COMBUSTION CHAMBER CONSTRUCTION.

As is well-known, the main points of combustion chamber constructed for pulverised fuel firing as applied to water-tube boilers, as shown in Fig. (1), are hollow air-cooled walls, very large volume, and the water screen. It is the furnace end of pulverised fuel that has always presented the most difficulties because of the intense heat developed, and the serious erosive and other deleterious action of the molten ash. To-day the extensive application of this method of firing is prevented in the iron and steel and many other industries mainly because of the slag and the wear and tear on the brickwork. In steam generation, however, with water-tube boilers, there is no question the problems have been solved mainly by the combined effect of air-cooling the brickwork and installing a series of water-cooled 4 inch steel tubes in the bottom of the furnace, that is, the water screen. As a consequence, the ash is kept very cool and does not melt. Combined with this is the use of a very large combustion chamber, and burners placed at such an angle that no part of the flame can impinge on the brickwork, so that the combustion must be completed before reaching the boiler tubes. All kinds of refinements are, however, being continually introduced.

The latest method adopted at Lakeside is to make the aircooled walls of much lighter construction, with a 1½ inch patent brick ("Solicel") outer wall lined internally with steel instead of the heavy brickwork employed. The water screen is continued as usual, but now the ash pit at the bottom slopes downwards at an angle of 38° as compared with the previous flat shape, so as to facilitate the continuous discharge of the ash to the conveyor at the bottom.

Another interesting refinement in furnace construction is air-cooling of the burning arches by having a housing over the outside of the arch setting and drawing over it the 10-15% of cold air required for combustion, which is passing to the adjustable speed fuel feeders supplying the burners. This raises the cold air to about 75° F., cooling the arches without wasting any heat.

One of the most remarkable of later inventions is the "Murray" water tube or "fin" wall, the invention of Thomas E. Murray, and first applied about 12 months ago at the Hell Gate Power Station, New York, in conjunction with multiple retort mechanical stokers. Essentially the principle consists in constructing the two side walls of the combustion chamber and the back wall as well, if necessary, of 4 inch steel tubes placed at 7 inch centres. To the side of each tube is welded a projecting steel plate or fin, one of which is 2¼ inches, and the other 1¼ inches from the tube surface. These plates or fins overlap, so that the wall is built up of 4 inch tube and 3 inch steel plate. The feed-water circulates through the tubes, entering by means of a common header at the bottom and being discharged through a common header at the top into the boiler. The result is an enormous increase in the nett heating surface of the boiler next to the combustion space for the absorption of radiant heat, and remarkable results have been obtained at Hell Gate, up to 92.7% boiler plant efficiency with mechanical stoking by the use of this appliance.

The "Murray" wall is now being adopted for pulverised fuel as an addition to the water screen, so that very soon we shall have combustion chambers almost entirely constructed of water-cooled tubes.

A further interesting invention, at present mainly used in conjunction with the travelling grate stoker, is the suspended fire-brick arch on the "Detrick-Usco" and "Liptak" principles, which is being applied to pulverised fuel. The principle consists essentially in building the arch or roof of the combustion chamber of a series of interchangeable standard firebrick blocks having a tee slot in the top, suspended from flat heavy steel girders having cast iron supporting or arch bars that fit into the slots. In this way a composite roof can be constructed of any span or shape, merely depending upon the strength of the girders, and the wear and tear is very greatly reduced as there is no strain on the individual blocks due to expansion, contraction, or compression of a mass of brickwork.

(To be Continued.)

General Notes.

RECENT DEVELOPMENTS IN LEAD AND ZINC MINING IN EASTERN CANADA.

The High Commissioner for Canada in has received from the Dominion Department of Mines the following article which has been prepared by Mr. W. B. Timm, of the Mines Branch:—

"The strong position of lead and zinc in the world market and the possibility of this continuing for some years, due to the fact that there have been no large mines of these metals found during the past decade, has stimulated search for new properties and the re-opening of idle ones.

In Eastern Canada, a number of properties of the latter class have been taken up, one has been brought to the producing stage, and others are being examined. A brief description of these, namely the Stirling, Notre Dame, Richardson and Frontenac mines, is given. The Reader mine, Calumet Island, Que., is still idle. Exploratory and development work is progressing on the Zinc and Lead Company., Gaspé Peninsula. The Kingdom mine, Galetta, Ont., continues its favourable production.

ENQUIRIES ON OVERSEAS COMMERCIAL MATTERS.

The Department of Overseas Trade desires to remind United Kingdom exporters requiring information on overseas matters that it is always desirable to approach the Department rather than to write directly to the Department's representative posted in the market concerned. It is frequently the case that the information desired is already available in the Department, and direct application to the Department thus results in the saving of much time. Where the information is not so available, the Department takes immediate steps to secure it and to forward it to the enquirer.

It is particularly emphasised that the method adopted by some enquirers of addressing the same enquiry simultaneously to the Department and its overseas officers leads to unneccessary duplication of work and to delay. Enquirers will, therefore, find it to their advantage to proceed in the manner suggested above.

A NEW CORROSION PREVENTATIVE.

Remarkable Results Obtained From Mond Chemist's Discovery.

The announcement of a new Mond company, the Mond Tar By-Products Syndicate, to put on the market a colloidal bituminous paint now being used very extensively in the factories and workshops of the group, has a very considerable significance for the whole engineering industry, if the claims made for the new preservative are substantiated in general practice.

This paint, with a guaranteed forty per cent. bitumen content, ground and mixed with a spirit base to give it a remarkable colloidity, was produced some years ago from a formula discovered by a chemist in the employment of the South Staffordshire Mond Company. He was endeavouring to solve the problem of the firm's high maintenance costs due to the corrosive action of the fumes from the power-gas and sulphate of ammonia plant on the steel and wood fittings The results obtained exceeded expectation, and when further tests were carried out, the paint gave evidence of very diverse properties.

As the quest for a preservative paint has been pursued for some time with indifferent success, it will be interesting to see whether Melanoid is found as satisfactory in the wider industrial world as it is said to have proved itself in the Mond works. Several firms are experimenting with it at the moment, and a large shipload has been ordered for use in the Japanese reconstruction schemes at Tokio. If it is generally taken up its influence on the steel industry may be far-reaching.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY.

Papers Read, June 25th, 1925, at 4.30 p.m.

D. H. Black.—*β-Ray Spectra of Thorium Disintegration Products.* Communicated by Sir Ernest Rutherford.

Using comparatively strong sources of thorium B in equilibrium with thorium C and thorium D, the β-ray spectra of these substances have been re-measured in order to bring them into line with the standard spectrum of radium B. While no attempt was made to obtain all the lines previously recorded in these spectra, as their values

could be found by interpolation from the main lines, yet several new lines were found. Of these new lines one group in particular is of great interest on account of the fact that, despite their high energy (2.5 million volts), they are due to the expulsion of electrons from the K, L and M levels of an atom by one γ-ray.

C. F. Elam.—*Tensile Tests of Crystals of an Aluminium Zinc Alloy.* Communicated by Prof. H. C. H. Carpenter, F.R.S.

Tensile tests have been made with an alloy of aluminium containing 18.6 per cent. zinc. The crystals resemble pure aluminium in structure and contain the zinc in "solid solution." They are harder and less ductile than pure aluminium, the actual figures varying with the orientation of the crystal relative to the axis. Fracture occurs on one or more planes at approximately 45° to the axis. These planes are closely related to crystallographic planes. Slip planes are sometimes, but not always, parallel to planes of fracture.

G. Shearer. *On the Distribution of Intensity in the X-ray Spectra of Certain Long-Chain Organic Compounds.* Communicated by Sir William Bragg, F.R.S.

It has previously been shown that, in the X-ray "spectra" of substances whose molecules contain long open chains of carbon atoms, there is a certain large spacing corresponding to planes whose distance apart is very closely related to the length, either of a single molecule or of two, end to end. A large number of successive orders of reflection from this plant can be observed and an attempt is made in this paper to explain the distribution of intensity among these orders in terms of the molecular structure. On certain simple assumptions as to the distribution of scattering material along the length of the molecule, the intensity distribution is calculated and a comparison with observation shows satisfactory agreement for the series so far examined. It is shown that by a study of these intensities it is possible, for example, to fix with reasonable accuracy the position in the chain of the CO group in such series as the ketones and the esters; this appears to open up a new application of X-ray methods to chemical analysis. It is hoped that further work on these lines will throw light on the relative scattering power of the various atoms and atomic groups.

C. F. Jenkin.—*High-Frequency Fatigue Tests.* Communicated by Sir Alfred Ewing, F.R.S.

The paper describes high-frequency fatigue tests on copper, Armco iron and mild steel. Results were obtained at frequencies as high as 2,000 periods per second, and unsuccessful experiments were made up to 5,000 periods per second. The results are compared with those obtained by Hopkinson, whose tests were made at 116 periods per second.

The tests show that there is a small rise in the Fatigue Limit as the speed is increased, but that it is too small to be of importance at any ordinary speeds. The dependence of the fatigue limit on the frequency has, however, an important bearing on the theory of fatigue failure.

The term "Fatigue Limit" in this paper is used to denote the greatest alternating stress which can be applied to a material for an indefinitely large number of periods without causing fracture. For many metals it is a little less than half their ultimate strengths, as found in static tests.

L. W. Bryant and D. H. Williams.—*An Investigation of the Flow of Air around an Aerofoil of Infinite Span.* Communicated by Prof. L. Bairstow, F.R.S. With an Appendix by G. I. Taylor, F.R.S.: "Note on the Connection between the Lift of an Aerofoil in a Wind and the Circulation round it."

The paper describes experiments made to determine the distribution of velocity of the wind around an aerofoil model of constant cross-section held with span vertical in the wind tunnel. Two-demensional flow was ensured by making the span of the aerofoil equal to the height of the wind tunnel. Stream-lines deduced from these observations were compared with those for inviscid flow, the latter being obtained by means of an electric tank in which the equipotential lines were equivalent to stream-lines in a perfect fluid. It is shown that, except for a narrow trailing "wake," the lines of viscous flow approximate to those for an inviscid fluid, when a circulation equal to that experimentally determined in the wind tunnel is superposed upon the flow around the aerofoil without circulation.

INSTITUTE OF CHEMISTRY.

The forty-seventh annual general meeting of the Institute was held at 30, Russell Square, London, W.C.1., on Monday, 2, March, 1925, Prof. G. G. Henderson, president, in the chair.

THE PRESIDENT'S ADDRESS.

(*Continued from Page* 412.)

The suggestion has been made that the Council should approach Parliament in the hope of inducing the Government to initiate legislation with the object of establishing a system of Government registration of chemists. In my judgment the Council would not be justified in taking this step until the project in all its bearings, had first of all been subjected to careful and critical examination and exhaustive discussion, and unless it received the support of at least the great majority of the members of our profession. Even a very cursory consideration of the proposal impresses one with the difficulties with which it is surrounded. For instance, registration would imply restriction of the right to practise as a chemist, and would require precise definition of those qualifications which would entitle chemists to be registered. To what tribunal is the duty of assessing the qualifications of applicants for registration to be delegated? Is this restriction to apply to all chemists, whatever branch of the profession—consulting, analytical, industrial, research, teaching—they may pursue for a livelihood? If not, where is the line to be drawn, and on what kinds or classes of chemists is the restriction to be imposed? Again, is a chemist to be prevented from earning a living in the practice of his profession because his qualifications are not sufficiently high to entitle him to registration? As regards registration, the relation of our profession to the public is different from that of medicine or of pharmacy, and I for one would not welcome legislation which would have the effect of restricting the freedom of any man to practice any profession or craft in which he can prove himself able to earn an honest living without hurt to his fellow citizens. In this matter I am expressing a personal opinion, and am quite open to conviction, but my feeling is that the question of Government registration of chemists is not at present within the sphere of practical politics.

I desire to direct the special attention of my fellow-members to the appeal recently issued by the Benevolent Fund Committee, for I feel sure that if they call to mind that the Benevolent Fund is the Institute's memorial of those of our members who gave up their lives in the defence of civilisation, and if they realise the value of the assistance given to some of our brother chemists, even with the limited amount at our disposal, the response to that appeal will be not only encouraging, but generous.

An event which cannot be passed over without notice is that at this meeting Mr. Richard Bertram Pilcher, O.B.E., completes a service to the Institute of thirty years as Secretary, and twenty-five years as Registrar. During the whole of this long period he has devoted himself to the duties of his office with a zeal, a loyalty, and an efficiency which are beyond praise. Only those members who have served in the Council can fully appreciate his manifold activities and his business capacity, but many others, and especially many of our younger members, have benefitted by his kindly help and by the information and advice which he has always been ready to place at their disposal. Feeling as they do that his services have been simply invaluable, the Council have invited the members to join in offering to Mr. Pilcher some tangible recognition of his work for the Institute, which has indeed been the work of his life, and I rejoice to inform you that a very large number has seized this opportunity of expressing their regard for him. I hope that for many years to come he will continue to adorn the office which his personality and his enthusiasm have made so important.

The Council has accepted with regret the resignation of Mr. Marlow, the Assistant Secretary, consequent upon his appointment to a post with the Association of British Chemical Manufacturers. His services to the Institute have been of very great value, and, although reluctant to be deprived of them, I congratulate him on his well-deserved promotion, and wish him all happiness and success in his new sphere of work.

When a year ago you conferred upon me the signal honour of election to the presidential chair I promised to do my best to maintain the high traditions of the office. No one can realise so clearly as myself that, if I have met with any success in endeavouring to justify the confidence which you reposed in me, the chief credit must be given to the administrative staff, without whose constant and willing support and assistance I could have done very little. Mr. Pilcher, Mr. Marlow, Miss Cawston, and indeed, all

the members of the staff have vied with one another in their efforts to make my work not only easy, but enjoyable, and I find it difficult to express my gratitude in adequate terms. I am also deeply grateful to my colleagues in the Council for the kindly consideration which I have experienced at their hands, and very specially to the Chairmen of Committees, whose labours have so largely contributed to the fulfilment of our duty to the members. Unfortunately we are about to be deprived, temporarily at least, of the services of a number of valued members of the Council, and on your behalf I tender them cordial thanks for their devotion to the affairs of the Institute.

PHOTOCHEMICAL REACTIONS IN LIQUIDS AND GASES.

The Faraday Society will hold a general discussion on this subject at Oxford on October 1 and 2 next.

The subject will be discussed under two main heads:

1. Einstein's Law of Photochemical Equivalence;
2. The Mechanism of Photochemical Reactions.

Part I. will be opened by Professor A. J. Allmand (King's College), and Part II. by Professor M. Bodenstein (Berlin). In addition to the leading English workers on photochemical action, many distinguished investigators from the continent and America have signified their intention of taking part in the proceedings and an attractive programme of papers has been prepared. It is hoped to accommodate all who attend the meeting at Exeter College and Lincoln College. Non-members of the Faraday Society may attend the meeting and those desirous of doing so are asked to communicate at once with the Secretary of the Faraday Society at 90, Great Russell Street, London, W.C.1., from whom full particulars may be obtained.

PHYSICAL AND CHEMICAL SURVEY OF THE NATIONAL COAL RESOURCES.

In pursuance of the policy of carry out the work of the above survey with the help of local Committees, the Fuel Research Board have appointed a committee to deal with the physical and chemical survey of the coal seams in the North Staffordshire area.

The composition of the Committee is as follows:—

Representing the North Staffordshire Colliery Owners' Association:—
Mr. J. Cocks,
Mr. J. Gregory,
Mr. G. P. Hyslop,
Mr. E. P. Turner.

Representing the North Staffordshire Institute of Mining Engineers:—
Mr. S. Henshaw.

Representing the Geological Survey of Great Britain:—
Mr. J. A. Howe.

Representing the Fuel Research Board:—
Dr. C. H. Lander (*ex officio*),
Director of Fuel Research;
Mr. F. S. Sinnatt (*ex officio*),
Superintendent of the Physical and Chemical Survey of the National Coal Resources.

MERCURY HELIDE?

J. J. Manley, *Nature*, June 20, 1925, reports that the helide previously announced in the same Journal of March 7, 1925 (see also *Chemical News*, 1925, CXXX., 217), as HgHe, turns out to be $HgHe_{10}$, as there was a decimal point error in his original calculation. The molecular weight of this compound, if it can be considered as such, would then be 240.61, approximating to the atomic weight of uranium, 238.17.

This body, whatever it may be, is interesting as it seems to approximate to a radioactive atom, in that such an atom gives off helium, stopping at lead, which is only a few units greater in atomic weight than mercury.

Sir William Ramsay, in discussing the behaviour of the inert gases, or particularly that of helium (*Ann. Chim*, 1898, 7, XIII., p. 38), referring to the ionization effects when subjected to electric discharges, said: "It would seem, however, that dissociated [electronically] as they are under the action of electricity, some chemical activity ought to be induced under these circumstances, and the reason why it has not been observed is that the amount thus dissociated is too small to be recognisable by any ordinary chemical agent." The words are those given in Tilden's "The Elements," 1910.

We await with interest Manley's paper, which, we understand, is now ready for publication.

WEMBLEY EXHIBITION EXHIBITS.

THE GAS LIGHT AND COKE COMPANY.—Stand No. A.45.—The Company's exhibit cannot fail to interest visitors in any way connected with the chemical industry or with one of the many branches of trade which employ chemical products. In view of the constantly increasing demand for road materials, the Gas Light and Coke Company's activities in their production deserve special mention. The Company is one of the largest makers of distilled tar in the country, and tar is universally recognised as being in the very front rank. The Company now also supplies a tar compound under the designation "Beetaphalt," which is specially prepared to meet the requirements of surveyors, and may be confidentially expected to take up a leading position amongst materials of this nature. Of the more highly refined products, special interest attaches to Beta Naphthol, in view of the efforts which the British dye-industry is putting forth to establish itself in the world's markets.

THE GENERAL KAPUTINE SYNDICATE, LTD., Stand No. A.43, show plasters, oils, ointments, creams, etc. Equipped with their own printing and box-making plants, they are in a unique position to meet the requirements of those who want their own names or brands on the lines they handle.

GRIEVE AND GORDON. Stand No. A.46, of Sydney and London, are here exhibiting eucalyptus oil, and its by-products. They have a complete working plant distilling and refining the oil ready for use. The oil is produced from a species of shrub known as Eucalyptus Polybractea, or Blue Mallee. It will interest many people to know that there are over 170 species of eucalyptus tree which oil is obtained. The oil obtained from Eucalyptus Polybractea has a very high pharmaceutical value, owing to its large cineol or eucalyptol content, which averages over 80%, whereas the British Pharmacopœia Standard is 55% cineol.

C. R. HARKER STAGG AND MORGAN, LTD., Stand No. A.37, show "Peldo," a recent invention which is to all appearance an ordinary skin cream, but when it is applied and rubbed into the hands it completely vanishes and there is no trace left on the hands. It forms practically an invisible glove. During the time that "Peldo" is on the hands, any kind of dirty work can be undertaken with impunity, as the user is safe in the knowledge that as soon as the job is finished, a wash under the cold water tap with a piece of ordinary soap will remove all dirt and grime from the hands and nails.

C. S. ISAACS, Stand No. A.51, show "Radine," a colourless antiseptic fluid which, in addition to its fine antiseptic qualities, is absolutely non-poisonous and may, therefore, be employed in a household without the fear that frequently accompanies the use of purely toxic preparations.

QUICK AND COMPANY, LTD., Stand No. A.48c, show "Otark" furniture polish, an entirely new preparation which polishes and removes stains from furniture, cleans and polishes leather and imitation leather upholstery, and renders it perfectly waterproof. It is also excellent for linoleum.

NOTICES OF BOOKS.

Organic Syntheses—An Annual Publication for the Methods of Preparation of Organic Chemicals. 90 + VIII. Price 7/6 per vol. London: Chapman and Hall, and John Wiley and Sons, Inc., New York.

These annual volumes give the most convenient laboratory methods for preparing various organic chemical reagents, in one-half-pound to five-pound lots, each method being adaptable to large-scale development. Editorial Board - Roger Adams, University of Illinois; Hans Thatcher Clarke of Eastman Kodak Company; James Bryant Conant of Harvard University; and Oliver Kamm of Parke, Davis and Company. In four volumes. Each volume contains detailed directions for the preparation of about thirty reagents.

New Patents.

This list is specially compiled for *The Chemical News* by Rayner and Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

15,121.—Badische Anilin and Soda Fabrik.—Manufacture of arsenic preparations. June 10th.

15,290.—Buchner, M.—Process of produc-

ing hydroxides and carbonates. June 14th.

14,878.—Elektrizitatswerk Lonza.—Preparation of metaldehyde. June 8th.

Specifications Published this Week.

212,914.—Agoleum Ges.—Process of preparing stable colloidal solutions of silver and mercury.

234,585.—Klopstock, Dr. H., and Neumann, W.—Processes for the production of potassium carbonate.

226,217.—British Thomson Houston Co., Ltd.—Extraction of metals and their compounds from ores and impure materials.

Abstract Published this Week.

232,898.- Aluminium Cements.—Patrouilleau, L. G., and Alumine et Derives, 2, Cite Monthiers, Paris.

Cements, Portland, materials and compositions for. - A substance capable of furnishing sulphur dioxide is added to the raw materials for making aluminous cement to prevent the formation of silicates. The added substance may be hydrogen sulphide, sulphur, sulphides, hyposulphites, sulphites, sulphates, sulphur dioxide, sulphur troixide, or the product of dehydration of the acid H_2SO_3. It may be added before, during, or after charging the materials into the furnace, or if gaseous mixed with the blast. Examples are given illustrating the use of iron pyrites, ferrous sulphate, ferric sulphate, aluminium sulphate, and calcium sulphate.

Messrs. Rayner will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

" THE CHEMICAL NEWS."

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

DETERMINATION OF LEAD IN MINUTE QUANTITY IN BAKING POWDERS, LIME, ALUM, TARTRATES, CITRATES, AND CARBONATES IN THE PRESENCE OF IRON AND COPPER.

By WILFRED W. SCOTT.

(*Professor of Analytical Chemistry, University Southern California, Los Angeles, California, U.S.A.*)

The method herein given is the result of an investigation in an effort to obtain a suitable method for determining minute quantities of lead in baking powders, alums, cream of tartar, and similar products in which traces of lead would be considered objectionable.

Lead may be determined quantitatively in three general ways:

(a) Gravimetrically in the form of an insoluble salt, as a sulphate, a chromate, a sulphide, etc.

(b) Electrolytically in the form of lead peroxide.

(c) Colourimetrically in the form of a coloured salt.

The first and third of these general methods are employed in the scheme of analysis. The conversion of lead to an insoluble salt that will dissolve in a special reagent from which it can be reprecipitated in a form readily seen in very dilute solutions, is the method in brief. The purpose of the first step is to eliminate elements that would give dark sulphides, the form in which lead is best seen in dilute soutions. Iron and copper are metals apt to occur with lead in the class of materials for which this method is desired. Bismuth, tin, cobalt, and nickel, fortunately, will be eliminated in the process. The sulphites of those undesirable metals are soluble, while lead sulphate is insoluble, a fact that makes it possible to remove lead.

The following table gives the solubility of the elements in parts per 100 and shows why the sulphate of lead is the best form for the first step in the analysis.

Metal		Sulphate	Chromate	Phosphate	Sulphide	Chloride
Lead	...	0.00420	0.00002	0.000014	0.00010	0.673
Iron	...	32,80000	——	Insoluble	0.00089	74.390
Copper	...	20,00000	Insoluble	Insoluble	0.00003	70.600

The solubility of lead sulphate in an ammoniacal solution of ammonium acetate is taken advantage of in the removal and solution of the lead left with the insoluble material after being digested with dilute sulphuric acid and alcohol, in which mixture lead sulphate is practically insoluble. The sulphate of lead is preferable to the chloride, the latter, though much more soluble in water, is difficultly soluble in the acetate reagent if any free hydrochloric acid was originally present in the residue. The sulphate of lead, on the other hand, dissolved readily enough, although free sulphuric acid be present. It is only necessary to add an excess of ammonia before addition of ammonium acetate to effect solution of lead.

The limits of delicacy of this method range from 0.01% to 0.0005% on a ten-gram sample, though, of course, this range could be increased on larger or smaller samples. than the upper limit were too dark for an accurate colour comparison. Lead sulphide precipitated with the concentration of 0.002 grams per fifty cc. of solution, although as low as 0.00001 gram lead per 50 cc. of solution, could be faintly seen in form of the sulphide, yet this was not sufficiently definite for accurate work.

Phosphates of lead are practically insoluble in ammoniacal ammonium acetate. Fortunately, sulphuric acid decomposes those salts forming lead sulphate and the free phosphoric acids.

$Pb_3(PO_4)_2 + 3H_2SO_4 = 3PbSO_4 + 2H_3PO_4$

The facts above stated, and experiments further confirming the scheme by testing substances with known amounts of lead, iron, and copper, induced us to believe the following method of analysis to give accurate results. The nature of the material to be examined should be taken into account. Products containing aluminium and iron require sulphation and subsequent removal by leaching out the material with dilute sulphuric acid. Phosphates and carbonates being objectionable, require this treatment also, whereas material fre from these may be extracted directly with ammoniacal ammonium acetate (cold if starch is present), thus greatly shortening the method. The presence of tartaric or citric acid and metals forming colourless salts with hydrogen sulphide are not objectionable in the lead extract.

METHOD OF ANALYSIS FOR TRACES OF LEAD.

I.—In the presence of Carbonates, Phosphates, Chlorides, Iron, Copper, Aluminium and Starch. (See Notes.)

(a) *Sulphation.*

Place a 10-gram sample of tin material to be tested in a 500 cc. Kjeldahl flask. Wash donw the material clinging to the neck of the flask with a few cc. of distilled water. (Baking powders will effervesce; allow reaction to subside.) Add 200 cc. of C.P. H_2SO_4 for samples containing not over two grams of starch; 5 to 10 cc. of additional acid will be required for each gram of starch in excess of the amount stated, add 5-10 grams of acid potassium sulphate. Place the flask over a low flame, then gradually increase the heat until the acid boils gently. If the frothing is too violent, add a piece of paraffine about the size of a small pea. Continue the digestion at boiling temperature until the carbonaceous matter is entirely in solution and finally oxidised. The occasional addition of a few cc. of concentrated nitric acid will aid in the oxidation. When the solution has become colourless or a pale straw colour, cool and dilute with a few cc. of cold distilled water and transfer to a 4-inch casserole or silica dish. Evaporate to removal of SO_3 fumes to insure complete destruction of organic matter and removal of excess of sulphuric acid.

(b) *Removal of Iron, Aluminium, Copper, etc.*

Extract the residue obtained by sulphation five or six times with fresh portions of 25 cc. of 5% sulphuric acid, together with 5 cc. of 95% alcohol allowing the undissolved residue to settle each time and filtering by decantation.

(c) *Extraction of Lead.*

Digest the undissolved residue with 50 cc. of hot ammoniacal ammonium acetate. Pour the supernatant liquor through the filter used in the above removal of iron, etc. Repeat the extraction two or three times, pouring the final liquid and residue on the filter. Wash with a few cc. of distilled water.

(d) *Estimation of Lead.*

Evaporate the extract to about 40 cc., cool and pour into a 100 cc. Nessler tube, adding the washings from the beaker (4 or 5 cc.). If copper is suspected, add 1 cc. of a 10% solution of potassium cyanide. Now add about 1 cc. of colourless $(NH_4)_2$ or Na_2S or H_2S water) and compare the results with standards.

(e) *Standards.*

Standards for comparison are made by adding known amounts of lead in solution to 25 cc. of ammoniacal acetate. KCN is also added if used in the sample being analysed. 1 cc. of colourless ammonium sulphide is finally added, and the volume made up to 50 cc. Convenient standards can be made to contain 0.00005, 0.0001, 0.0002, 0.0005, and 0.001 gram of lead.

Permanent standards may be prepared by mixing in due proportions the sulphates of cobalt, ferric iron, and copper so that the resulting solutions will have the proper shade of colour representing a series of standards containing .00001 gram to 0.001 gram of lead. It is well to make a dark liquid of the proper shade and then to dilute portions to match standards containing known amounts of lead made as above directed. These permanent standards, sealed in test tubes, will keep indefinitely.

II.—Absence of Gelatinous Organic Matter, Ferrous Iron, Aluminium and Phosphates.

In the absence of these compounds, "sulphation" and "removal of iron, aluminium, etc." may be omitted and the material extracted directly with ammoniacal ammonium acetate. If tartaric, citric or other organic acids are present, the solution should first be made alkaline with ammonia and the extraction then made with the acetate mixture. Determination of lead in tartaric acid, citric acid and acetic acid may be made by simply adding ammonia until strongly alkaline and then ammonium sulphide. (Absence of elements other than lead giving dark sulphides.) Carbonates should first be decomposed by addition of water and a few

cc. of dilute sulphuric acid if necessary.

Lead may be extracted from materials containing starch by using an excess of cold ammoniacal acetate without previous sulphation, provided the starch is not in a gelatinous form, and ferrous iron, aluminium and phosphates are absent.

REAGENTS.

Ammoniacal ammonium acetate.- Add acetic acid to ammonium hydroxide (sp. gr. 1.90) until neutral, then add 50 cc. ammonium hydroxide in excess for each litre of solution.

Sulphuric Acid.– Alcohol Mixture.—To 500 cc. of water add 50 cc. of strong sulphuric acid and from 100 to 200 cc. of alcohol, 95%. Make up to a litre with water.

Potassium Cyanide. -10% solution.

Colourless Ammonium Sulphide, or Na_2S or H_2S water.

DISCUSSION—NOTES AND SUGGESTIONS.

In order to test out the accuracy of the method, a series of experiments were conducted with materials containing known amounts of lead, iron, and copper. The following facts are of especial interest.

Iron.—Tartaric acid and other organic acids that may be found in baking powders prevent the precipitation of iron by ammonia. Ferrous iron, if present in the mixture, will pass into the lead extract and render the colour test worthless. Amounts of iron exceeding 0.0002 gram per 50 cc. of It was found that samples containing more solution, although reduced to the ferrous condition and in the presence of KCN, give a decided colour with the sulphide reagent. The hydrates and especially the phosphates of iron occlude small amounts of lead so that an extraction by ammoniacal ammonium acetate is incomplete, even with a large excess of the reagent. A sample containing 0,0001 gram of lead gave no evidence of lead in the extract, 0.01 gram of iron being present in the original material. Advantage cannot be taken of the solubility of the sulphides of iron, nickel and cobalt, and the insolubility of the sulphide of lead in acid solutions (inorganic) since the presence of the free acid causes the decomposition of KCN if added to hold up copper, and furthermore, causes a cloudiness with the H_2S reagents. Organic acids do not prevent the precipitation of iron sulphide. These also cause precipitation of free sulphur, hence the solution must be alkaline (NH_4OH) before adding ammonium sulphide.

Aluminium.—The determination of lead in alum by direct extraction with ammoniacal ammonium acetate was found impracticable. The aluminium salt is decomposed by ammonia forming the gelatinous hydrate which completely occludes traces of lead. In a 10-gram sample of alum, 0.001 gram of lead could not be extracted with direct action of the reagent. Decomposing the hydrate with dilute sulphuric acid and alcohol and later extracting the filter paper with ammonium acetate mixture, 0.0001 gram of lead could readily be determined.

Determination of Lead in Water.

The occlusion of lead by $Al(OH)_3$ enables the determination of lead in water by the following method:—

Evaporate five litres of water to about three or four hundred cc. and add 10 to 15 cc. of 10% solution of aluminium sulphate. Add 5 to 10 cc. dilute sulphuric acid and then 25 cc. of strong ammonia water. Heat to boiling. Allow to settle until almost cold, then filter. Examine the residue by the colour method beginning with the "removal of iron, alumina, etc." Addition of barium chloride to the concentrated solution of water, then passing in H_2S gas and finally adding dilute sulphuric acid to precipitate the barium sulphate which occludes PbS, has been successfully practised in determination of minute quantities of lead in water. The residue treated with strong sulphuric acid to decompose the Pbs and then extracted by ammoniacal ammonium acetate according to the method given above, will carry the lead into solution free from iron. It can now be determined by the colour method.

REACTIONS.

$$3Pb(C_2H_3O_2)_2 + Al_2(SO_4)_3 + 6NH_4OH = 3PbSO_4 + 2Al(OH)_3 + 6NH_4C_2H_3O_2$$

$$Pb(C_2H_3O_2)_2 + BaCl_2 + 2H_2SO_4 = PbSO_4 + BaSO_4 + 2HCl + 2HC_2H_3O_2$$

Calcium.—In determining lead in products containing calcium, no difficulty was experienced in the extraction of lead. Phosphates and calcium are decomposed by sulphuric acid and calcium sulphate formed. This is not as soluble as iron in the acid reagent and will remain to a great extent with the lead residue. In the extraction of lead by ammoniacal acetate solution, calcium was found to pass into the filtrate; its presence, however, is not objectionable in the colour determination of lead. In a 10-gram sample containing 0.0001 gram of

lead in solution, the colour test gave accurate results.

Copper.—The sulphate of copper is soluble and can be easily removed from the lead residue by the dilute sulphuric acid treatment. The presence of lead in the final solution containing lead would offer no difficulty, however, for as much as 0.1% can be held in solution by 1 cc. of 10% KCN solution, the stable $Cu_2(CN)_2$ being formed.

Starch.—Lead may be extracted from starch by a cold solution of ammoniacal ammonium acetate. Heating the solution with the formation of gelatinous starch prevents the extraction of lead and renders the filtration tedious. By using an excess of the acetate solution, cold, 0.0001 gram of lead was easily detected in the extract, while ten times this amount of lead was occluded in a test where the starch was boiled in the extract. Should the starch or organic matter be in a gelatinous form it is necessary to conduct the sulphation as prescribed. Mere charring of the material is not sufficient, as the extract will be coloured. The organic matter should be thoroughly oxidised. The Kjeldahl method of sulphation was found to give the most satisfactory results, being rapid, economical and convenient. Ignition in a casserole was found to be tedious, more acid required and greater danger of loss by expansion of the material. Ten grams of starch can be readily oxidised by fifty to sixty cc. of concentrated sulphuric acid in a 500 cc. Kjeldahl flask in about two hours. Five to ten hours is necessary otherwise.

Organic Acids.—The presence of citric and tartaric acids do not affect the action of the soluble sulphide in an alkaline solution of lead, iron, copper, etc. In the absence of the latter elements, lead may be determined in these acids by simply making alkaline with ammonium hydroxide and adding colourless ammonium sulphide. KCN will prevent copper from colouring the solution.

SUMMARY.

The determination of lead in the form of the sulphide by the colour method is found to give accurate results in samples containing calcium, aluminium, small amounts of iron, and copper with phosphates, chlorides, sulphates, and carbonates and organic acids, together with organic material such as starch, flour, etc. The delicacy of the method on a ten-gram sample ranges from 0.01% to 0.0005%, the range being extended each way with smaller or larger samples according to the amount of lead present.

Tartaric or citric acids may be present in the final colour test without detrimental effect, provided the solution is alkaline (NH_4OH).

Iron and aluminium, in the form of gelatinous, insoluble compounds are objectionable in the extraction of lead by ammoniacal ammonium acetate. Starch, likewise, when boiled, retains the lead salt and prevents a successful extraction. Iron, if present in the extract, even though in the ferrous condition in presence of an excess of KCN, renders the colour determination of lead worthless as iron sulphide forms in presence of a soluble sulphide. Ferrous iron is soluble in ammoniacal ammonium acetate. Tartaric acid aids the solution of this metal, preventing the formation of the hydrate

Calcium salts are not objectionable in the lead extract. Copper may be present provided KCN is added to the solution before the addition of the soluble sulphide reagent.

The method of analysis is based on the principle that the sulphate salts of iron, nickel, cobalt, and copper are soluble in dilute sulphuric acid containing alcohol, whereas the lead sulphate is insoluble. These objectionable metals may be thus removed, the lead salt extracted from the insoluble residue by ammoniacal ammonium acetate, from which reagent it may be converted to the coloured sulphide by a soluble sulphide. The coloured solution is compared with a standard containing a known amount of lead.

A number of experiments conducted on materials containing known amounts of lead in soluble form have given evidence of the reliability of the method of analysis. The process is applicable to determination of traces of lead in baking powders, alum, lime, organic acids, foods canned goods, beverages, and water

HYSTAZARIN-DIQUINONE, OR 2, 3, 9, 10-ANTHRA-DIQUINONE.

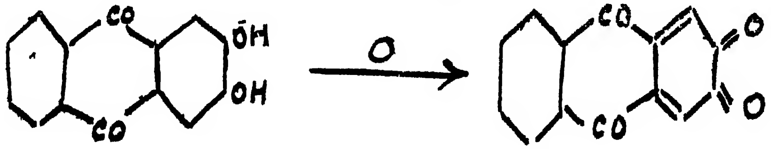
By MUNENARI TANAKA.

The derivatives of hystazarin are, as yet, little known owing to the very difficult method of preparing hystazarin and to its extremely small solubility in most organic solvents. It is easily soluble in pyridine only, with which, however, according to Pfeiffer (*Annalen* CCCXCVIII, 149), it

forms a salt. The author has prepared hystazarin according to Liebermann's method (Liebermann and Schöller, *Ber.*, XXI., 2503. Liebermann and Hohmann (*ibid.*, XXI., 1780), but only obtained a yield of 8%. This method, however, seems to be the best way of preparing hystazarin since, in comparison, the patented method (*D.R.P.* No. 298345), only yielded a trace of the substance.

The testing of its purity offers difficulties, since it dissolves only in a dilute aqueous solution of sodium hydroxide, giving a characteristic cornflower blue colouration, and its melting point is indistinct, the substance darkening above 315° C. The best test is to dissolve it in pyridine, add acetic anhydride, and thus prepare the di-acetyl derivative, which melts very sharply at 207° C (Dimroth, *Ber.*, LIII., 481.)

The oxidation of dihydroxy-anthraquinone has been investigated by Lesser (*ibid*, XLVII., 2526), and Dimroth (*Annalen*, CCCCXI., 346). Both obtained 1.4. 9. 10-anthra-diquinone by the oxidation of quinizarin with lead peroxide. The first investigator used benzene as solvent, whilst the latter worked with glacial acetic acid. This oxidation product is unstable, whereas the oxidation product obtained by the present author is rather stable, even in the dry condition. The oxidation process is represented by:—



EXPERIMENTAL.

For the preparation of hystazarin-di-quinone, 3 grs. of the pure pyridine salt of hystazarin were used and were rubbed into a paste with the smallest requisite amount of glacial acetic acid. Whilst stirring vigorously, 6 grs. of lead tetra-acetate (Dimroth, *Ber.*, LIII., 485) were then gradually added, the addition being accompanied by the evolution of heat and a change in the colour of the mixture to brownish-red. The stirring was continued for some minutes until all the hystazarin disappeared. A small portion of the mixture was then placed under a microscope and a drop of glacial acetic acid added. When no yellow crystals of hystazarin appeared on the addition of acetic acid, the mixture was quickly filtered, and sucked thoroughly dry on a filter-pump, the lead salt washed off, by glacial acetic acid, and the substance finally dried in a vacuum desiccator. The dry substance was then finely powdered, heated (below 150° C.) for a short time in a large amount of hot nitrobenzene, and quickly filtered. The di-quinone then crystallised in beautiful red needles, accompanied by some yellow needles of hystazarin. This latter by-product can be removed easily, the best method being by the addition of pyridine, which removes it entirely. After being allowed to stand overnight and being sucked dry at the filter-pump, red, well-defined crystals of the pure di-quinone (resembling copper bronze) were obtained. To purify them from the last traces of lead salt, which it is difficult to remove, two re-crystallisations from warm nitro-benzene were necessary, and a subsequent drying in a vacuum-toluene bath. Yield 5%.

Analysis.—$C_{14}H_6O_4$, Mol. Wt. 238.

2.98 mgrs. substance yielded 7.62 mgrs. CO_2 and 0.86 mgrs. H_2O.

Per cent carbon—Found,	69.8;	calc. 70.6
Per cent hydrogen	3.21;	2.52

The elementary analysis is naturally indecisive of the purity of the substance; this can only be found by determining the amount amount of oxidation, which oxidation was not further studied by Willstätter (Willstätter u. Majima, *Ber*, XLIII., 1172). To determine this oxidation, 2 grs. of potassium iodide were dissolved in the smallest amount of water necessary, and two drops of very pure concentrated hydrochloric acid added. In another beaker, 0.0112 grs. of the mixture under investigation were warmed for a short time with glacial acetic acid and after cooling the hydriodic acid was added. After standing for about half an hour, the solution was diluted with 20 grs. of water, and titrated by means of thiosulphate solution.

This analysis gives:—

0.0112 grs. of substance taken,

Actual amount of N/20 thiosulphate used = 1.85 cc.

Calculated amount of N/20 thiosulphate required = 1.88 cc.

PROPERTIES.

The 2, 3, 9, 10-anthra-diquinone forms, as already mentioned, characteristic red needles, having a metallic lustre. Its melting point is indistinct, and above 315° C. the substance darkens.

It is insoluble in ether, chloroform and benzene; sparingly soluble in alcohol, acetone, acetic acid and pyridine; being more soluble in warm nitro-benzene. It thus differs from hystazarin in being less soluble in pyridine and dilute aqueous solutions of sodium hydroxide, and in producing no blue colouration in the latter solvent.

All solutions of this di-quinone are red, the substance is stable in air, but sensitive to hydriodic (Levy and Schultz, *Annalen* CCX., 142), and sulphurous acids by which it is reduced to hystazarin—the reaction being shown by a change in the colour of the solution from red to brownish-yellow.

PULVERISED FUEL.

THE LATEST DEVELOPMENTS CONSIDERED ALONG WITH LOW TEMPERATURE CARBONISATION, IN RELATION TO THE MINING INDUSTRIES.

By DAVID BROWNLIE. B.Sc. (Hons.) Lond., F.C.S., M.I.Chem.E., A.M.I.Min.E., etc.

Read before the Manchester Geological and Mining Society, on May 12, 1925.

(*Continued from Page* 9.)

HUGE BOILER UNITS.

One of the most striking results of pulverised fuel firing has been the almost incredible size of water-tube boilers that is rendered possible. The ordinary standard colliery "Lancashire" boiler of 30 feet by 8 feet, as usually worked without economisers and superheaters, is evaporating about 4.000 lbs of water per hour. Not very many years ago the standard water-tube boiler in the power station world was 20,000 lbs. evaporation per hour, and very few stations, even to-day, possess individual boilers of larger size than 50,000 lbs. It may be stated in this connection that the largest boilers in Great Britain are at the Barton power station in Manchester, with a normal duty of 100,000 lbs., and 120,000 lbs. overload on mechanical stoking.

With pulverised fuel, however, it is possible with one boiler for no less than 400,000 lbs. of water per hour to be evaporated comfortably, and, as already stated, the Cleveland and Trenton Channel boilers will give this figure for long overload duty. At the present time, however, the largest steam boiler in the world belongs to the Allegheny County Steam Heating Company, operating at their new Cecil Power Station situated on the Allegheny River in the town of Pittsburg. This is used mainly for supplying steam heating to the business district of the town and this particular new boiler, which is fired with "Lopulco" pulverised fuel on the usual plan, has no less than 32,750 square feet heating surface, which includes, however, the water screen for the prevention of slagging. There is also fitted the "Murray" water-cooled side walls, and the working pressure is 150 lbs. per square inch, although in the future this will be put up to 190 lbs. as soon as the rest of the plant has been modernised. The furnace volume is 19,350 cubic feet, the cross drum of the boiler being 34 feet in length by 5 feet in diameter, whilst the pulverising fuel equipment consists of two 6-roll "Raymond" pulverising mills, each with its own exhaust fan, suction collector, screw conveyors and 16 burners.

A boiler of this size is, of course, a remarkable achievement in itself, and corresponds to a normal evaporation on pulverised coal of something like 325,000 lbs. water from and at 212° F., with an overload of 425,000 lbs., or, in other words, equal to over 100 "Lancashire" boilers 30 feet by 8 feet, as now worked at collieries.

The record in Europe, previous to Vitry, was at the Gennevilliers Station in Paris, 132,000 lbs. per hour, with mechanical stokers. Until recently, 160,000 lbs. evaporation per boiler per hour was regarded as about the limit for this method of firing, but in the United States huge multiple retort stokers are being constructed for 300,000 lbs. evaporation per hour, which are to be installed at the new Kearney station of the Public Service Corporation of New Jersey, U.S.A. There are 16 retorts wide and 13 tuyeres deep, with a furnace 26 feet wide and 16½ feet deep, operating boilers of 23,600 square feet heating surface, burning normally 30,000 lbs. (13 tons) of coal per hour, presumably equal, therefore, to the evaporation of about 300,000 lbs. of water from and at 212° F. per hour. However, it is the opinion of many engineers that we shall soon have, with pulverised fuel firing, the 400.000 lb. evaporation per hour boiler, with 500,000 lbs. overload, so that one boiler

will form a self-contained unit with a 40,000 K.W. turbine.

Air Heating.

Another interesting development of pulverised fuel firing, equally with mechanical stoking, is air heating. To-day the general tendency in large power station design, especially with cheaper coals, is to use the air heater instead of the feed-water economiser. On these lines, a modern pulverised fuel furnace equipment consists of hollow air-cooled front wall, water screen, and steel tube water-cooled back and side walls, air heater, superheater, but no feed-water economiser. The air is heated to about 250°-300° F. in the air heater and then passes through the hollow furnace walls and enters the combustion chamber at say 500 700° F., although, naturally, there are endless modifications possible to suit the circumstances.

Air heating on these lines has been adopted at the Cofax station, Pittsburg, following upon the detailed investigations made by C. W. E. Clarke, the designer of the station, on the working of the "Usco" air heater in conjunction with mechanical stoking, as recorded in his well-known paper read on air heating in December, 1923, before the American Society of Mechanical Engineers, followed by a second this last January (1925).

Radiant Heat Superheaters.

This is another interesting development of julverised fuel firing, which, of course, applies equally well to mechanical stoking. As is well-known, one of the inherent defects of superheating is the erattic temperature of the steam due to fluctuations in the demand. Consequently the temperature alters because the corresponding variation in the heat given out by the furnace to cope with the new conditions is not quick enough in the case of mechanical stoking to prevent the degree of superheat falling when the steam demand rises, or conversely increasing as the supply diminishes. The completely automatic control of superheat temperature is, however, not yet a practical proposition even with pulverised fuel, oil, and gas firing, which are all sufficiently flexible, consequently the radiant heat superheater is being used, placed near the incandescent brickwork because the temperature of the mass of material remains and the heat emitted approximately the same whether the amount of combustion is increased or diminished, so that the temperature of superheat is much steadier. The matter is rather serious in the case of superpower station conditions at say 72.)° F. superheat temperature, because with ordinary superheaters this cannot be controlled exactly, and at 750° F. the danger point of steel as regards resistance to pressure and temperature, for example, begins to be reached.

One of the most prominent radiant heat superheater installations for pulverised fuel firing is that at the newest extensions of Lakeside. The superheater elements are of cast steel and have a heating surface only about 1/8th that of the ordinary convection type, as in the earlier sections of Lakeside, being placed across the rear wall of the furnace, replacing a certain amount of the brickwork, and being exposed to the direct heat of the furnace. In this way the steam is heated 50-100° higher than that of the convection superheater with eight times the heating surface, whilst giving a much more even temperature of superheat. Also other advantages of the radiant heat superheater as applied to pulverised fuel is, stated to be based on considerable large scale experience, still further reduced wear and tear on the brickwork, lower exit furnace temperature, higher CO_2, and even greater thermal efficiency than before.

Another striking advance in the science of steam generation is rendered possible by is the almost completely automatic boiler plant. The method of entire control of the working of a steam boiler from a distant switchboard was the first developed at the Ford plant, River Rouge Detroit. As is well-known, on this installation, which taking everything into account, is probably the most scientific power plant in the world, running entirely on distilled water and burning all the blast furnace gas available at high efficiency, irrespective of the fluctuations, each of the very large boilers of 26,400 square feet heating surface in the first section of the plant is controled by an operator who sits at a switchboard with a complete battery of instruments in front of him, and merely operates tiny switches which control the supplies of blast furnace gas and pulverised coal, used as fuel, together with the air and feed water, whilst on the latest section of the plant, one operator controls four boilers. There has now, however, been developed automatic control in which the rate of flow of the pul-

verised fuel and the air is controlled electrically by means of steam meter mechanism, which operates the pulverised fuel feeders and the dampers, being so arranged that the relative proportion of fuel and air always remains constant for maximum efficiency. This, of course. is an entirely different principle from the elementary one, originally used by William Brunton before 1820, of trying to control the operation of boiler plant with mechanical stoking according to the steam pressure only, which is nothing like sensitive enough, either at the steam or the combustion end.

At Cleveland the automatic control is of still omre advanced characterfi being in two sections, the first of which gives automatic operation for each boiler, whilst the second is a master control operating on the total demand of steam from the whole installation, and shuts down or starts up individual boilers. As before, the control on each boiler works in such a manner that the supply of air and of pulverised fuel operates jointly, so that the maximum amount of CO_2 and efficiency of combustion is always maintained irrespective of the amount of fuel being burnt.

(*To be Continued.*)

General Notes.

RAILWAY CENTENARY CELEBRATIONS, 1825—1925.

Commemorative Medal Struck.

An interesting point in connection with the Railway Centenary Celebrations which will be held at Darlington is the striking of a very beautiful bronze commemorative medal.

This medal ,which has been designed and modelled by Mr. Gilbert Bayes, F.R.S.B S , shows:—

On the Obverse, portraits of Edward Pease, chairman and guiding influence in the management of the first public railway, and of George Stephenson, who built the first engine on the railway and actually drove it on its historic journey on September 27th, 1825. There are also shown the coats-of-arms of Stockton and Darlington, the two towns between which ran the world's first passenger train, the arms of Stockton being on the left-hand, and those of Darlington on the right.

On the Reverse are shown a figure of Vulcan holding in his hand "Locomotion No. 1," the first engine to be employed on a public railway, with, in the background, one of the L. & N.E. Railway Company's famous 1925 type "Pacific" express locomotives.

CANADIAN POULTRY FARMING.

According to the Canadian Official Press Bureau in London, the production of eggs in Canada increased from 202,185,508 dozen, valued at £9,500,000, in 1923, to 212,648,685 dozen, valued at well over £10,000,000, last year (1924).

Exports of eggs from Canada in 1924 amounted to 2,619,356 dozen, worth £280,000, an increase in value of nearly £100,000 over the previous year.

British Columbia is one of the principal poultry provinces. New settlers in the southern portion frequently combine poultry raising with fruit growing.

THE OLDEST CHAMBER OF COMMERCE.

The Fairs and Merchant Guilds of mediæval Europe may be considered the actual prototypes of the modern Chamber of Commerce.

The Marseilles Chamber has always laid claim to be the oldest Chamber of Commerce in the world. This claim has just been substantiated according to the *Journée Industrielle* by the discovery by Monsieur Joseph Fournier, archivist and librarian of the Marseilles Chamber of Commerce, of the original letters patent granted by Henri IV. on the 15th April, 1600, whereby the King approved the institution of the "Bureau de Commerce," which was the origin of the Marseilles Chamber.

The Bureau was instructed on the 5th August, 1599, on local initiative, and as the result of a deliberation of the General Council of the town of Marseilles. The King's approval was granted by letters patent on parchment sealed with the Seal of France in yellow wax. For the last 325 years the document has lain hidden in a bag containing legal papers, since at the moment of its foundation, the Marseilles "Bureau de Commerce" was obliged to engage in a law suit, which it won, before the "Cour des Comptes" at Aix.

Some of the earliest British Chambers are the following: Jersey, 1768; Glasgow,

Dublin and Belfast, 1783; Edinburgh and Leeds, 1785; Manchester, 1794 The London Chamber of Commerce, representing the commercial interests of the wealthiest of the world's cities, is in comparison a young institution, and was formed and incorporated in 1881.

As regards British Chambers of Commerce established in foreign countries, the British Chamber of Commerce, Paris, is the oldest and dates from 1873. Our own Chamber follows next in point of age, having been established in 1887.—*Journal of the Chamber of Commerce of Turkey and the Balkans.*

TEMPERATURE REGULATORS

We have received from the Cambridge Instrument Company a list describing the Cambridge Automatic Temperature Regulators, which have now important uses in a variety of ways. The regulators can also be applied to the control of humidity, pressure, etc. Diagrams illustrating some of the applications of the regulators are given.

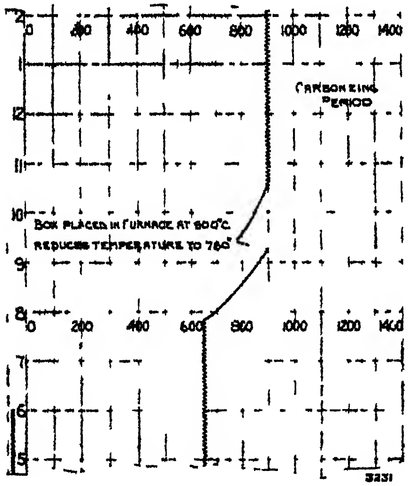


Fig. I.

When it is remembered that in many processes temperature must be kept within narrow limits in order to secure satisfactory results, it will be readily understood that the Cambridge Patent Temperature Regulators, which can be implicitly relied upon, are not only useful but virtually indispensable in connection with various industries. Apparently they can be adapted to various other uses besides those for which they are more specifically intended to apply.

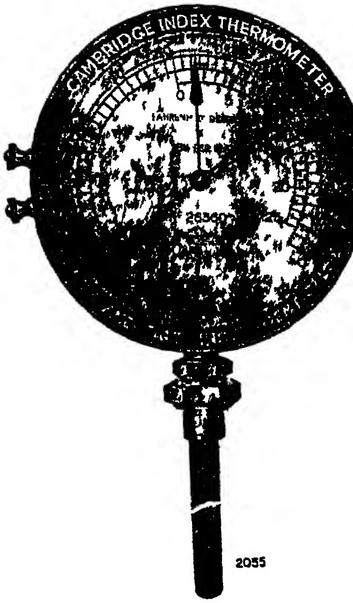


Fig. II.

An as example of the efficiency and usefulness of the apparatus, the record reproduced in Fig 1 is of interest. It shows the variations in temperature of a gas-fired furnace used for annealing and carbonising processes. The record commences at the foot of the illustration. Up to nearly 8 o'clock the furnace was used for annealing, and its temperature was automatically controlled at 650° C. by the Regulator. It was then desired to utilize the furnace for carbonising -and its temperature was increased to 900a C. When this temperature was reached (at 9.15) a box was placed in the furnace, causing the temperature to drop to 780° C. Heating was continued until the temperature again reached 900° C., at which value it was automatically controlled by the Regulator throughout the carbonising period. The closeness with which the desired temperature was controlled is clearly indicated on the record.

MOND NICKEL COMPANY, LIMITED.

The profits last year came to £297,887, as compared with 262,634 the previous year, and pays the same dividend, *viz.*, 12½ per cent. on the ordinary shares, as in the previous year. The Company has adopted the sound policy of drastically writing down the value of its Canadian and British plant. A new capital issue will increase its cash liquid resources by close upon a million pounds.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers Read, Thursday, June 25, 1925, at 4.30 p.m.

D. H. Black. *β-Ray Spectra of Thorium Disintegration Products.* Communicated by Sir Ernest Rutherford.

C. F. Elam.—*Tensile Tests of Crystals of an Aluminium Zinc Alloy.* Communicated by Prof. H. C. H. Carpenter, F.R.S.

G. Shearer. *On the Distribution of Intensity in the X-Ray Spectra of Certain Long-Chain Organic Compounds.* Communicated by Sir William Bragg, F.R.S.

C. F. Jenkin. *High Frequency Fatigue Tests.* Communicated by Sir Alfred Ewing, F.R.S.

L. W. Bryant, and D. H. Williams. *An Aerofoil of Infinite Span.* Communicated by Prof. L. Bairstow, F.R.S. With an appendix by G. I. Taylor, F.R.S. *Note on the Connection between the Lift of an Aerofoil in a Wind and the Circulation round it.*

Papers Read in Title only.

T. H. Havelock, F.R.S. *Wave Resistance: the Effect of varying Draught.*

C. V. Raman, F.R.S., and L. A. Ramdas. *The Scattering of Light by Liquid Boundaries and its Relation to Surface Tension, Part III.*

W. H. George. *An Electrical Method for the Study or Impact applied to the Struck String.* Communicated by Prof. E. H. Barton. F.R.S.

F. H. Constable *The Mechanism of Catalytic Decomposition.* Communicated by Sir William Pope, F.R.S.

S. A. Emerson and L. C. Martin. *The Photometric Matching Field. II.* Communicated by Prof. H. L. Callendar, F.R.S.

G. S. Adair. *Partial Osmotic Pressures and Membrane Equilibria.* Communicated by Sir William Hardy, Sec., R.S.

Mary W. Porter. *A Contribution to the Study of the Optical Properties of Mixed Crystals.* Communicated by Sir Henry A. Miers, F.R.S.

H. Gregory and C. T. Archer. *Experimental Determination of the Thermal Conductivities of Gases.* Communicated by Prof. H. L. Callendar, F.R.S.

D. B. Deodhar. *On the Atmospheric Radio-Activity and Indian Weather.* Communicated by Prof. O. W. Richardson, F.R.S.

J. R. Partington and A. B. Howe. *The Ratio of the Specific Heats of Hydrogen.* Communicated by Prof. H. B. Dixon, F.R.S.

A. Cary an E. K. Rideal. *The Behaviour of Crystals and Lenses of Fats on the Surface of Water. Part I.* Communicated by Sir William Hardy, Sec. R.S.

G. H. Henderson. *The Capture and Loss of Electrons by α-Particles.* Communicated by Sir Ernest Rutherford, F.R.S.

A. S. Parkes. *The Effects on Fertility and the Sex-ratio of Sub-Sterility Exposures to X-Rays.* Communicated by Prof. A. V. Hill, F.R.S.

R. N. Chrystal. *The Genus Dreyfusia (Order Hemiptera Family Chermesidæ) in Britain, and its Relation to the Silver Fir.* Communicated by Prof. A. W. Hill ,F.R.S.

T. Moran. *The Effect of Low Temperatures on Hens' Eggs* Communicated by Sir William Hardy, Sec. R.S.

And other papers.

PHYSICAL SOCIETY OF LONDON.

May 8, 1925.

F. E. Smith, C.B.E., F.R.S., President, in the chair.

A Magnetic Bridge for Testing Straight Specimens and an Analysis of the Hysteresis Loop of Cobalt-Chrome Steel, by Edward Hughes, B.Sc., A.M.I.E.E.

The author employs a permeameter resembling that of Iliovici, in which the currents in two coils providing the M.M.F. of a magnetic circuit containing the specimen are adjusted until no magnetic potential difference exists between a selected pair of fixed points on the specimen. In the present apparatus the required absence of magnetic potential difference is tested by bringing up a yoke till its end abut upon the two points in question: the approach of the yoke should excite no current in a search coil wound on the specimen and connected in a low-resistance galvanometer circuit. Resistance is then added to the galvanometer, and the deflection caused by a reversal of the two magnetising currents enables the permeability to be calculated. The hysteresis loss per c.c. per cycle in cobalt-chrome steel is found by this method to be 0.056 $\beta_{max.}$ ergs where $\beta = B—H$. The

magnetisation curve for this substance, above the point of inflexion near the origin, is found to be given by $\frac{H-c}{\beta} = d + \frac{H}{\beta}$, where β is the saturation value of β, and c, d, are constants. To form a permanent magnet whose energy per c.c. is within 5 per cent. of the maximum obtainable, a magnetising force of upwards of 1,000 C.G.S. units must be applied. The βH loop between the $+\beta$ and $-H$ axes is given by a formula similar to that for the magnetisation curve, with different constants instead of c, d, β.

DISCUSSION.

Mr. D. Dye: The modification of the means of ascertaining that the compensation for reluctance of the joints, etc., of the Iliovici permeameter has been correctly made appears to be a considerable improvement in this apparatus. The use of a movable exploring yoke instead of the reversal of the main magnetising current is in effect equivalent to the introduction of a statical means of determining that the magnetic potential difference between the two points of contact of P with the specimen is sensibly zero. The straightness of the reluctivity curves shows that this method of indication is not seriously in error when magnetising forces greater than about 5 C.G.S. units are in operation. Since, however, the causes mentioned under (2) in the Paper are still operating when the yoke is brought up into contact with the specimen, the condition experimentally realised is actually that the magnetic potential difference between the points of contact of the specimen remains unaltered when the yoke is brought into contact and not necessarily that this magnetic potential difference is quite zero. There will, in general, be a small magnetic potential difference between the ends of Y owing to the leakage field referred to. The effect on the curves obtained by the apparatus will be to shear the hysteresis loop in such a fashion that the coercive force points remain unaltered. This effect still leaves the loop of a normal looking shape and no immediate judgment can be made as to its accuracy. It is when such loops are obtained by a more standard method that the differences are observed. it is doubtful whether the hysteresis loops of materials having a coercive force of 2 C.G.S. units or less can be accurately measured by any type of permeameter in which H is deduced from a magnetising current and an effective length of specimen which is determined or adjusted to a known value experimentally. The conditions are, of course, very different in the case of materials in the other extreme condition, *i.e.*, hardened magnet steels. An uncertainty in H of 1 unit at the remanence point is of comparatively little importance.

With regard to the statement that the Iliovici permeameter cannot be used in its normal form for hysteresis loop determination, I am not quite clear why this should be so. If the procedure outlined by the author when using his method is followed except that the search coil T is used, then by whatever means the M.M.F. is provided round the path $A\ C\ M\ D\ B$, so long as the final result at the test points of Y is a sensibly zero magnetic potential difference, then the E.M.F. provided by N is that which is expended along the specimen up to the two test points of the yoke Y. The switching procedure by which the desired point on the loop is reached must, of course, be exactly rehearsed when testing by search coil T. The advantages of the movable yoke are, however, so obvious that the point need not be pressed further.

The chief cause of the double throw referred to by the author is, I think, the solidity of the main yoke. In testing apparatus used at the National Physical Laboratory, in which yokes of large section are used, we have found it very advantageous to build them up of laminations of stalloy sheet punched to a suitable shape.

The observations on the variation of the hysteresis index as a function of B_{max}. are of considerable interest. There is a field for much investigation on this point. The variations of the index appear to be associated with curvature of the BH curve. In the case of the softer magnetic materials, there seems considerable ground for believing that the index rises as B diminishes from a value near to 2,000 to zero and that it rises again from 12,000 upwards. At values of B above 17,000 or 18,000 it is to be anticipated that the index must fall again since the hysteresis loop is tending to a finite area, although B_{max}. may continually increase.

The introduction of the additional constant "c" in the reluctivity equation (a) is an improvement not only in that it enables a greater portion of the βH curve to be represented, but also that it suggests a line for future work in correlating "c" with the

coercive force of the material. This also ollows from the experimental fact that the portion of the hysteresis loop between β_{max}. and $+H_c$ follows very closely the βH curve. We have found this to hold for many kinds of magnetic material. With regard to the author's conclusion as to the high magnetising force required if the maximum energy per c.c. is to be retained, I have found this to be true for cobalt steels ,but for ordinary tungsten magnet steels it is unnecessary to carry the magnetising force to such high values. A good rule to adopt in tests on magnet steels of all kinds is to carry the magnetising force up to a value of 8 or 10 times the coercive force expected.

Dr. D. Owen suggested that some of the difficulties of Iliovici's method might have been got over by the use of a fluxmeter, but the present method shares with the magnetometer method the advantage that it enables time changes to be observed by applying the test yoke a second time after an interval of fifteen seconds or so. Had the author examined in this way the question whether a balance when once obtained was permanent for a given adjustment? Similarly, it would be possible to observe the effect of a rise in temperature. No physical explanation was available for the usual increase of the index of B, in Steinmetz's formula, with increase in the value of B. The author's discovery that in the case of cobalt-chrome steel the index decreases instead of increasing adds another phenomenon to those which must be explained by any theory on this subject.

Mr. Rollo Appleyard referred to the fact that in Iliovici's original method two successive kicks of the galvanometer are obtained for each reversal of current, as mentioned by the author. Is this phenomenon to be attributed to the difference in the lengths of the two magnetic paths concerned? How are the time constants relevant to the respective kicks to be defined?

Mr. W. C. S. Phillips asked how long it takes to carry out a test by this method? It used to be usual to specify the coercive force and retentivity of magnets, but it was difficult to get rapid determinations for commercial purposes. Had the author checked his results against standard determinations, and what limits of accuracy did he attribute to his method?

A paper on *The Experimental Control of Electrically Broadened Spectral Lines*, was read by M. Johnson, B A.

The simple relation to average current density, previously relied upon to describe low-pressure broadening of the lines in a hydrogen discharge, is shown by examination over a finer range to represent a rough approximation only. Concentration is ions is the obvious controlling factor of the Stark hypothesis be adopted: recombination of ions on this hypothesis may explain the capacity and inductance curve obtained n these experiments, between 0.3 and 1.0 A.U. This view is further tested by controlling the broadening without altering the current in the tube or the period of the discharge; for this, a range of widening over which rectified and unrectified discharges which rectified and unrectified discharges show lines differing in width, is provided by a magnetic field. The several effects involved in this experiment are accounted for on the theory that line width depends on the number of charges which surround an emitting particle. A thermionic method is also employed for varying the line width, by drawing into the discharge ions additional to those produced by collision.

Discussion.

Mr. J. Guild said that this interesting paper contained some very suggestive results. The author had referred to Rossi's finding that a simple relation existed between the broadening of the lines and the current density, in the rather special sense in which the latter expression was used. Such a law should give a simple relation between the width of the lines and the intrinsic luminosity of the discharge. Had that point been tested? Such a result seems unlikely in the case of heavy ions like those of mercury, because in such cases the width can be varied considerably, for a given intrinsic brightness, by varying the design of the tube. What effects would be observed where two or more elements were present in the discharge tube—in the case of a mixture of gases, for instance? It might be expected, on the author's theory, that the width of a given line would in such cases be affected by the existence of neighbouring charged particles which were not themselves capable of emitting that line. The author had found that the range of his ovservations was limited by the overlapping of the various orders of the spectrum obtained with an echelon. Could he not, however, measure the broadening from the path differerence over which interference would be visible? The results so obtained would be of lower accuracy, but the range could be extended by this means.

Dr. L. Simons referred to Prof. Wien's work on the "duration of luminosity," or period of phosphorescence of atoms. A luminous atom can be conceived of in classical terms as emitting radiation with an amplitude which is exponentially damped, but the same phenomena can be equally well regarded in terms of the quantum theory as due to the statistical effect of a number of atoms each of which radiates a quantum catastrophically, the radiation being separated from the excitation by a period of time which varies from atom to atom in such a way as to produce a total effect identical with that of exponent damping. The author's results might be regarded from the classical point of view as due to the influence of ions on the decay factor of a damped oscillation, while on the quantum hypothesis the recognised theory of the Stark effect would be correspondingly applicable.

Dr. G. Temple said that it had been found difficult to devise experimental tests for Sommerfeld's prediction of a resolution of $H\alpha$ into a pair of lines, each consisting of a triplet. Schramm has recently succeeded in verifying this prediction, having photographed the fine structure of $H\alpha$, $H\beta$ and $H\gamma$, but he had to work at the temperature of liquid air. Would it be possible to study separately th ewidening of each component of such spectral lines

A paper on *The Spectra of the Metals of the Aluminium Sub-Group*, by K. Rangadhama Rao, M.A., Madras University Research Scholar, was taken as read in the absence of the author.

Continuing the previous work on absorption of light by thallium vapour, the author has now studied the absorption of Tl vapour from λ2400 to λ2000, and that of In from λ6000 to λ2000. The absorption of tube was of steel, and provided with quartz windows at the ends, and absorption was studied with a quartz spectrograph. Tables were given in each case of the wavelengths of the lines absorbed. The absorption spectra indicate marked similarities. The first members of the series, $1\pi_2—m\delta'$, of both Tl and In, are found to exhibit assymmetrical absorption. In both cases there appear at high temperatures and on the short wave side of $1\pi_2—2\delta$ a channelled space spectrum consisting of assymmetrical bands degraded towards the red.

None of the lines of the principal series appeared in absorption, even at the highest temperatures used by the author. One remarkable feature is the very marked absorption of the members of $1\pi_2—m\delta'$.

A demonstration, entitled, *The Diffraction of Light by a Spherical Obstacle*, was given by Professor A. O. Rankine, O.B.E., D.Sc.

It was pointed out by Professor Porter in 1914 that owing to the existence of the well-known white spot at the centre of a circular shadow, a circular obstacle could be used to project an image of an extended source of light. Each point in the source of light yields its own white spot, and the sum total of the white spots constitutes an inverted image which obeys he same law of magnification as the image due to a pinhole. Owing to the fact that only one point in the source of light can lie on the optical axis a certain amount of aberration occurs with a circular obstacle, but Prof. Rankine avoids this difficulty by using a spherical obstacle such as a steel bicycle ball. Sources of light of various shapes and about 2 mm. in linear dimensions were made by pasting black strips on a lantern slide; a ball of about 7 mm. diameter was fixed a few feet away from this, and the image, having a magnification of about 3, was exhibited on a ground glass screen.

THE FARADAY SOCIETY.

Annual General Meeting.

The Annual General Meeting, 1925, was held in the Rooms of the Chemical Society Burlington House, Piccadilly, London, W., on Monday, July 6, at 5.15 p.m.

Agenda.

1. Receive annual report of Council and accounts.
2. Elect Officers and Council for year beginning October 1, 1925. (The nominations of the Council have already been circulated.)
3. Elect Honorary Auditors.
4. Votes of thanks to retiring Members of Council, Honorary Auditors, and President and Council of Chemical Society.

Ordinary Meeting.

An ordinary meeting was subsequently be at 5.30 p.m. The following papers were read:—

A. L. Marshall. *The Electrodeposition of Zinc from Acid Zinc Sulphate Solutions.*

F. L. Usher. *The Nature of the Interfacial Layer between an Aqueous and a Non-Aqueous Phase.*

J. B. O'Sullivan. *The Application of the Quinhydrone Electrode to the Measure-*

ment of pH Values in Solutions containing Copper Ions and other Divalent Ions.

J. A. V. Butler. *Co-ordination and Valency.*

E. D. Campbell. *A Chemical Theory of Permanent Magnetism.*

NOTICES OF BOOKS.

The Electrolytic Separation of Magnesium from Magnesit. By Ichitario Namari. 160 pp.

The present work is by a Japanese author of repute, is written in English, and is profusely illustrated. In his introduction, the author says that he has made a series of researches on the subject of utilising magnesia for the preparation of metallic magnesium and its allies from magnesia, while working in the Central Laboratory of the South Manchurian Railway Company. He points out that the subject has assumed greater importance from the fact that in South Manchuria immense deposits of magnesite have been discovered quite recently, of an excellent quality

Chemistry to the Time of Dalton, by E. J. Holmyard, M.A., F.I.C. Pp. 128. London: Oxford University Press. 1925. Price 2s. 6d.

Mr. Holmyard's historical investigations have created a new interest in the history of science in general, and that of chemistry in particular. The present volume, one of a series of World's Manuals, under distinguished editorship, deals briefly with the development of chemical science from the earliest times to what may be considered as the beginning of modern chemistry,

In the earlier sections on Greek and Arabian science, Mr. Holmyard has presented much that is not generally included in historical surveys of science. The knowledge of the Arabians and their contributions to the total stock of science was of far greater importance and extent than has hitherto been realised.

The beginnings of chemical science in this country took place during the "Dark Ages," and from that period Mr. Holmyard has dealt more especially with the influence of English scientists upon the general development of chemistry.

The Phlogiston theory and Lavoisier's discoveries are given special chapters, as are Boyle and his contemporaries and Dalton, but the work of the English contemporaries of Scheele is compressed into a single chapter. J. G. F. D.

New Patents.

This list is specially compiled for *The Chemical News* by Rayner and Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

15,877.—Badische Anilin and Soda Fabrik.—Catalytic oxidation of ammonia. June 19th.

15,710.—Cicali, G.—Apparatus for synthesis of ammonia. June 17th.

15,621.—Sandoz Chemical Works—Process of making allium preparations. June 16th.

15,934—Stickings, R. W. E.—Manufacture of organic compounds of bismuth for therapeutic purposes. June 19th.

Specifications Published this Week.

234,933.—Smith, T. B., and Simon-Carves, Ltd.—Method of producing white commercial pure ammonium chloride.

215,734.—Wittig, A.—Method of producing metallic vanadium.

235 015.—Karpen and Bros., S. Manufacture of hexamethylenetetramine.

235 014.—Carbide and Carbon Chemicals Corporation. — Processes of making concentrated chlorhydrin solutions.

223 572—Soc. D'Etude Des Agglomeres.—Process for the commercial production of pure oxide of zirconium.

Abstract Published This Week.

233,029.—Treating copper ores.—Taplin, T. J., 16, Lordship Park, Stoke Newington, Perkins, W. G., and Metals Production, Ltd., 62, London Wall, both in London.

Dry processes of extracting copper; ammonium compounds containing metals.—In a process of treating oxidised copper ores in which the ore is rendered amenable to leaching by an ammoniacal solvent by so heating it in a reducing gas at a temperature insufficient to melt the copper or frit the gangue, that the reduced material is obtained in a porous condition, as described in Specification 185,242, the material is cooled from the reduction temperature in a reducing gas or in an inert gas such as nitrogen or carbon dioxide to below 200° C., *e.g.*, to

100° C. or less. The cooling may be rendered uniform by passing the material through an externally cooled rotary tubular conveyor, such as the apparatus described in Specification 209,020.

Messrs. Rayner will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

The Latest TRADE MARKS

The following list of latest Trade Marks Published, is specially prepared for "*The Chemical News,*" by Messrs. Rayner and Co., Regd. Patent and Trade Mark Agents, of 5, Chancery Lane, London, who will give all information free regarding the Registration of British and Foreign Trade Marks.

ACIDSTONE.

455,158.- Anti-Corrosives. — Walter Hayhurst trading as Guthrie and Co., 8, St. James' Chambers, Accrington. June 17th, 1925.

ARESIN.

458,948.– Chemical Substances used for Agricultural and Horticultural purposes. - Bayer Products, Ltd., 31, to 34, Basinghall Street, London, E.C.2. June 17th, 1925.

OXANTASE.

457,047.- - Pharmaceutical and Therapeutical Preparations. — Farbwerke Vorm Meister Lucius and Bruning, Hoechst-am-Main, Germany. June 17th, 1925.

VYTT.

157,242.—Chemical Substances prepared for use in Medicine and Pharmacy.—Dae Health Laboratories, Ltd., 68, Bolsover Street, London, W.1. June 17th, 1925.

STIBOSAN.

458,184.—Chemical Substances prepared for use in Medicine and Pharmacy—Chemische Fabrik Von Heyden Aktiengesellschaft, 57, Leipzigerstrasse, Radebeul, near Dresden, Germany. June 17th, 1925.

The above Marks have been "accepted" by H.M. Patent Office, and unless any objection is lodged, the Marks will be duly Registered They are, however, officially advertised for opposition, which must be lodged within one month from date quoted. All particulars and forms for opposition will be sent free by Messrs. Rayner and Co., 5, Chancery Lane, London.

THE CHEMICAL NEWS,

VOL CXXXI. No. 3405.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES:
Administrative Central 6521
Printing Works, Hop 2404.

ACTIVE HYDROGEN.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The following matter is intended to concern only the two hydrogen atoms of a molecule of water, and those atoms of hydrogen which form the active portions of acids and bases. However, a large amount of matter concerning oxygen must necessarily be considered at the same time. The H-atoms which are directly united with carbon and nitrogen in organic compounds will have to be treated separately.

A molecule of water of crystallisation always occupies a volume 14.03.

TABLE I.

RELATIVE VOLUME OF WATER OF CRYSTALLISATION.

		Theor S.G. 15° C.	Obs. S.G.	
(1)	$FeSO_4$ 49.03.	3.100	3.138	Playfair and J.
			2.841	Filhol
(2)	$FeSO_4 + 3H_2O$ 49.03 + 3(14.03)	2.261	2.268	16° Pape
(3)	$FeSO_4 + 7H_2O$ 49.03 + 7(14.03)	1.888	1.8889	4° Playfair
(4)	$MnSO_4$ 45.12	3.347	3.386	Playfair
			2.845	15° Thorpe
(5)	$MnSO_4. H_2O$ 45.12 + 14.03	2.857	2.870	14° Pettersson
			3.282	15° Thorpe
(6)	$MnSO_4\ 2H_2O$ 45.12 + 2(14.03)	2.556	2.526	15° Thorpe
(7)	$MnSO_4. 3H_2O$ 45.12 + 3(14.03)	2.351	2.356	15° Thorpe
(8)	$MnSO_4. 5H_2O$ 45.12 + 5(14.03)	2.091	2.087 - 2.095	Kopp
(9)	$CuSO_4. H_2O$ 40.13 + 14.03	3.270	3.246	18° Pettersson
			3.289	15° Thorpe
(10)	$CuSO_4. 2H_2O$ 40.13 + 2(14.03)	2.860	2.808	16° Pape
			2.878	Playfair
(11)	$CuSO_4. 5H_2O$ 40.13 + 5(14.03)	2.258	2.254	Playfair
(12)	$Na_2B_4O_7$ 85.39	2.366	2.367	Filhol
(13)	$Na_2B_4O_7$ + 10 H_2O 85.39 + 10(14.03)	1.692	1.692	Filhol
(15)	Na_3AsO_4 72.13	2.88	2.86	21° Stallo
(16)	Na_3AsO_4 + $12H_2O$ 72.13 + 12(14.03)	1.765	1.762	Schiff
(17)	Na_3PO_4 64.4	2.547	2.536	17.5° Hohr i.e., 2.54 15°
(18)	Na_3PO_4. 12 H_2O 64.4 + 12(14.03)	1.633	1.622	Playfair
			1.6645	Dufet
(19)	$SrCl_2. 6H_2O$ 19.56 + 2(15.085) + 6(14.03)		1.964	Muhlberg
		2.0	2.015	Playfair
(20)	$SrBr_2. 6H_2O$ 19.56 + 2(23.09) + 6(14.03)	2.37	2.358	18° Favre
(21)	$Sr(NO_3)_2$ 72.84	2.93	2.947	Le Blanc
			2.89	Karsten

(22)	$Sr(NO_3)_2 . 4H_2O$ 72.34 + 4(14.03)	2.211	2.249 2.113	15.5° Favre Filhol
(23)	H_2SO_4 2(8.59) + 35.61	1.8564	1.857 1.839	Bineau 15° Perkin
(24)	$H_2SO_4 + H_2O$ 2(8.59) + 35.61 + 14.03	1.74	1.778	15° Perkin
(25)	$H_2SO_4 + 2H_2O$ 2(8.59) + 35.61 + 2(14.03)	 1.657	1.6655 1.65084	0 Mendelejef 15° Perkin
(26)	$H_2SO_4 + 3H_2O$ 2(8.59) + 35.61 + 2(14.03) + 18.02	1.54	1.55061	15° Perkin

No. 24 is the sulphuric acid Thomsen must have always employed. It corresponds with No. 50 and is demonstrated in Nos. 76-81.

Many other examples of the volume 14.03 for water of crystallisation were given in articles published in *The Chemical News* last year.

14.03 splits up into 2(5.76) + 2.51; and 5.76 and 2.51 have frequently been shown in preceding papers to be the commonest volumes of H and O respectively.

The heat of formation of water of crystallisation at 18° C. is

$$65555 = 2(-15300) + 96155$$

which corresponds exactly with

$$2(5.76) + 2.51$$

as frequently demonstrated in previous papers.

The heat of formation of liquid water at 18° C., or, in other words, the heat of combustion of H_2 is

$$2(-24350) + 117460 = 68760 = 2(34380)$$

Thomsen's value is $68360 = 2(34180)$
and Berthelot's $69000 = 2(34500)$

Therefore when liquid water becomes water of crystallisation it absorbs 68760 - 65555 = 3205 calories, and vice versa.

The reason why Thomsen found that the heat of neutralisation was always about 3205 greater when he employed H_2SO_4 than when he used HCl or HNO_3 was that the molecule of crystallised water in combination with sulphuric acid became liquid water during the process and thereby evolved 3205 calories.

This is a point where Thomsen's judgment miscarried. He evidently thought that water of crystallisation was equivalent to ice. The latter, of course, evolves heat when formed from liquid water. He had obtained the fact that the difference between the heat of formation of liquid water and that of water of crystallisation was about 3205, but which of the two was the greater he could not decide. His judgment required the one, but the facts the other. Anyhow, he decided that his judgment was right and the facts were wrong. The consequence is that his two chapters on Hydration and Solution are totally wrong. They are chiefly the results of calculation arranged as though they were experimental facts.

Even if he had taken the other course, the right one, he would have been no nearer the discovery he was evidently aiming at, *viz.*, the Law of Heat of Formation. For this law could only be discovered by the previous discovery of the Relative Volumes of the Elements, which are the Fundamental Constants of Nature.

After spending his life in seeking the truth, the disappointment caused by his failure to discover the law must have been very great. He sought consolation in claiming such discoveries (?) as the following:—

"It is noteworthy that the last four numbers are *multiples of a common factor*, namely:—

$Fe_2 Cl_6$	= 192080	= 14	×	13720
$Fe. Cl_2$	= 82050	= 6	×	13675
$Fe. O. H_2O$	= 68280	= 5	×	13656
$Fe_2. O_3. 3H_2O$	= 191150	= 14	×	13654

As there is no room in this paper for several examples of liquid water absorbing 3205 calories in the process of becoming water of crystallisation, or vice versa, only a few cases (Nos. 73, 74, 76-81) will be given at present. Others will be continually occurring in later papers.

117460 is a value for the heat of formation of oxygen, which occurs only in liquid water and aqueous solutions.

Table II. gives the four values for oxygen, and it will be seen that they are so absolutely different from one another, and so definite that it is impossible to confuse them.

H.F. of Oxygen.

(27)	32341	= 795 × 2.54 × 16
(28)	71515	= 795 × 5.62 × 16
(29)	96155	= 795 × 7.56 × 16
(30)	117460	= 795 × 9.234 × 16

TABLE II.

Equivalent Vol. Vol.		Rel. Vol. 15° C.		Change of Vol.
10.07	=	7.53	+	2.54
10.07	=	4.45	+	5.62
10.07	=	2.51	+	7.56
10.07	=	0.836	+	9.234

Therefore when the relative volume of an atom of oxygen is 7.53, 4.45, 2.51 or 0.836, its H.F. is 32341, 71515, 96155 or 117460 *respectively*. The fact that there are four pairs of corresponding values has not made the elucidation of the matter easier but much more difficult, since it is equivalent to there being four different atoms of oxygen to discover.

As 0.836 is the volume at 15° - 18° C. of the atom of oxygen in liquid H_2O, and since 18.02 is the total volume of the molecule, the volume of each H-atom must be 8.592, and its H.F. has been shown to be - 24350. (18.02 = 2 × 8.592 + 0.836).

Also 5.76 has been shown to be the volume of H in a molecule of crystallised water, and its H.F. - 15300; and it is evident that, if any relation can be found connecting the two pairs of values, this relation will confirm the matter.

TABLE III.

THE CONFIRMING RELATION.

Heat of Formation of Hydrogen.

			Orig. Vol.		Rel. Vol at 15° C.		Change of Vol.
(31)	-15300	= 3196 × (-4.79) × 1	0.97	=	5.76	-	4.79
(32)	-24350	= 3196 × (-7.62) × 1	0.97	=	8.59	-	7.62

This confirming relation is not a single but a triple one, for

(a) The two give the same original volume;

(b) This original volume has been given before (*Chemical News*, 1924, CXXVIII., 230.)

(c) The constant 3196 is common to both.

In addition to the fact that the volume 0.97 of H has been shown to be a constituent part of several elements, oxygen, sulphur, phosphorus, etc., it also appears in the molecules in Table IV

TABLE IV.

	Relative Volume.	Theor S.G.	Obs. S.G.	
(33) Pd_2H	2(9.05) + 0.97	11.0	11.06	Troost
(34) Pd_3H_2	3(9.05) + 2(0.97)	11.8	10.803	Dewar

The constant of H.F. in the sodium elements is 120, in the sub-sodium so that the intrinsic energy contained in an atom of hydrogen in water, bases and acids is more than four times as great (*ceteris paribus*) as that contained in the other sub-sodium elements, and more than 26 times as great as that in the sodium elements.

It is unnecessary to alter the wording of the Law of Heat of Formation on account of the above facts, since this state of the H-atom is peculiar to itself and does not occur in other elements.

It is evident that in the formation of water the whole of the heat evolved comes from the oxygen, the hydrogen absorbing a large amount. The same thing happens in the formation of CO_2, the carbon (whatever its form) absorbing heat.

As it is necessary now to show that the H.F. 68760 of liquid water has been correctly split up, the heat of neutralisation of acids and bases must be considered. Table V. contains experimental data which are necessary for this purpose.

TABLE V.

	Heat of Formation.		Theor.	Obs.	
(35)	aq. Na_2. S. O_4 2(32706) + 6217 + 2(32341 + 96155)	=	328621	328500	
(36)	Ba. O 54509 + 71515	=	126024	126380	
(37)	liq. H_2O −2(24350) + 117460	=	68760	68360	Thomsen
				69000	Berthelot
(38)	aq. Na. O. H 31234 + 96155 − 15300	=	112089	111810	Thomsen
(39)	aq. H. Cl − 24350 + 63870	=	39520	39315	T
(40)	aq. Na. Cl 32706 + 63870	=	96576	96510	T
(41)	aq. H. Br − 24350 + 52930	=	28580	28380	T
(42)	aq. Na. Br 32706 + 52930	=	85636	85580	T
(43)	aq. H. I. − 24350 + 37720	=	13370	13170	T
(44)	aq. Na. I 32706 + 37720	=	70426	70300	T
(45)	aq. H. N. O_3 −24350 − 23300 + 3(32341)	=	49373	49090	T
(46)	aq. Na. N. O_3 32706 − 23300 + 3(32341)	=	106429	106000	
(47)	aq. Li. O. H 36816 + 96155 − 15300	=	117671	117440	T
(48)	aq. Li. Cl 38416 + 63870	=	102286	102250	T
(49)	Ba. O_2. H_2 81926 + 96155 +71515 − 2(15300)	=	218996	219100	217000
(50)	aq. H_2. S. O_4. H'_2O −2(24350) + 6217 + 2(32341 + 96155) − 3205	=	211304	210770	
(51)	aq. Ba. S. O_4. H'_2O 81926 +6217 + 2(32341) + 2(96155) − 3205	=	341930	340200	
(52)	solid Ba. S. O_4 81926 + O + 2(32341) + 2(96155)	=	338918	339400	
(53)	aq. Ba. Cl_2 72134 + 2(63870)	=	199874	197100	
(54)	aq. Ba. Br_2 72134 + 2(52930)	=	177994	177080	
(55)	aq. Ba. I_2 72134 + 2(37720)	=	147574	146400	
(56)	aq. Na_2. Se 2(31234) + 18360	=	80828	79500	
(57)	aq. Na_2. O 2(31234) + 96155	=	158623	157200	
(58)	aq. Li_2. O 2(36816) + 96155	=	169787	166520	174500
(59)	aq. Tl. O. H −18360 + 96155 − 24350	=	53445	53760	
(60)	aq. Tl_2.S. O_4 −2(25460) + 6217 + 2(32341) + 2(96155)	=	212289	212700	
(61)	aq. Sr. O_2.H_2 67950 + 71515 + + 117460 − 2(15300)	=	226325	226140	T
(62)	aq. Sr. S. O_4 67950 + 6217 + + 2(32341) + 2(96155)	=	331159	330200	
(63)	aq.Co.O. H_2O − 32920 + 96155 + O	=	63235	63400	
(64)	aq.Co.S.O_4 − 32920 + 6217 + 2(32341) + 2(96155)	=	230289	228700	T
(65)	aq Cu.O.H_2O − 58590 + 96155 + O	=	37565	37520	T
(66)	aq.Cu.S.O_4 − 64975 + 6217 + 2(32341) + 2(96155)	=	198234	197500	
(67)	Ag_2.O − 2(45080) + 96155	=	5995	5900	T
(68)	aq.Ag_2 S.O_4 − 2(50300) + 6217 + 2(32341) + 2(96155)	=	157209		

Water of crystallisation will for the future be represented in these papers as H'_2O in order to distinguish it from liq. H_2O; the volume of the former being 14.03 and that of the latter 18.02 When the former is produced from the latter the heat of formation is − 3205; when the latter is produced from the former, the H.F. is + 3205.

HEAT OF NEUTRALISATION.

When (38) and (39) produce (37) and (40), the changes that occur are:—

96155	becomes	117460
31234	becomes	32706
- 15300	becomes	- 24350

(69) 117460 - 96155 + 32706 - 31234 - 24350 + 15300 = 13727 13780 T

When (38) and (41) produce (37) and (42) the changes are exactly the same as above, giving the heat of neutralisation as

(70) 13727 13750 Thomsen

When (38) and (43) produce (37) and (44) the H.N. is again

(71) 13727 13680 Thomsen

When (38) and (45) produce (37) and (46) the H.N. is again

(72) 13727 13680 Thomsen

Since Thomsen's results evidently demonstrate that the same changes occur in all four cases, it is correct to take the average of his experiments in order to obtain a greater approximation to the truth. The average is 13723.

HEAT OF HYDRATION.

When (36 and (37) produce (49),

54509	becomes	81926
117460	becomes	96155
2(- 24350)	becomes	2(- 15300)

(73) 81926 - 54509 + 96155 - 117460 - 2(15300) + 2(24350) = 21212 22260 T

HEAT OF NEUTRALISATION.

When (49) and twice (39) produce (53) and twice (37),

81926	becomes	72134
71515	becomes	117460
96155	becomes	117460
2(-15300)	becomes	2(-24350)

(74) 72134 - 81926 + 2(117460) - 71515 - 96155 - 2(24350) + 2(15300) = 39358 40040 T

When (47) and (39) produce (48) and (37),

(296155)	becomes	117460
-15300	becomes	-24350
36816	becomes	38416

(75) 117460 - 96155 - 24350 + 15300 + 38416 - 36816 = 13855 13848 T

When (50) and twice (38) produce (35) and twice (37),

2(96155)	becomes	2(117460)
2(31234)	becomes	2(32706)
2(-15300)	becomes	2(-24350)
- 3205	becomes	0

(76) 2(117460 - 96155) + 2(32706 - 31234) - 2(24350) + 2(15300) + 3205 = z30859 31380 T

When (50) and twice (59) produce (60) and three times (37),

2(-18360)	becomes	2(-25460)
2(96155)	becomes	2(117460)
- 3205	becomes	0

(77) 2(-25460) + 2(18360) + 2(117460 - 96155) + 3205 = 31615 31130 T

When (50) and (61) produce (62) and thrice (37),

71515	becomes	117460
2(-15300)	becomes	2(-24350)
- 3250	becomes	0

(78) 117460 − 71515 − 2(24350) + 2(15300) + 3205 = 31050   30710   T

When (50) and (63) produce (64) and thrice (37),

96155 becomes 117460
− 3205 becomes 0

(79) 117460 − 96155 + 3205 = 24510   24670   T

When (50) and (65) produce (66) and thrice (37),

− 58590 becomes − 64975
96155 becomes 117460
− 3205 becomes 0

(80) −64975 + 58590 + 117460 − 96155 + 3205 = 18125   18400   T

When (50) and (67) produce (68) and twice (37),

2(−45080) becomes 2(−50300)
96155 becomes 117460
− 3205 becomes 0

(81) − 2(50300) + 2(45080) + 117460 − 96155 + 3205 = 14070   14490   T

Summary.

Eighty-one experimental facts are here arranged in such a way that the truths which underlie them become evident. The chief deductions thereby obtained are:—

(a) That each H-atom of a molecule of liquid water is in exactly the same condition as the active hydrogen of an acid;

(b) that each H-atom of a molecule of water of crystallisation is in exactly the same condition as the active hydrogen of a base;

(c) that the law of heat of formation for active hydrogen is the same as that for the sodium and sub-sodium elements but the constant is very much greater.

In addition to making the above three definite discoveries, this paper accomplishes the following objects:—

(A) It continues the reduction of the experimental data of specific gravity to exact instruments of research;

(B) It continues the demonstration of the impossibility of calculating the heat of formation of substances, as done by Thomsen;

(C) It commences the demonstration of the fact that water of crystallisation is not equivalent to frozen water.

(D) It continues the demonstration of the Co-relationship of Physico-Chemical Constants (Diagrams re the Magnetic Rotation and Optical Refractivity of active hydrogen being much too voluminous to be included in a short paper were sent to the Nobel Institute in 1923.)

THE ACTION OF HALOGENS ON PHOSPHORUS PENTASULPHIDE. PART I. PRELIMINARY EXPERIMENTS ON THE BROMINATION OF PHOSPHORUS PENTASULPHIDE.

By R. F. Hunter, B.Sc., A.R.C.S.

During the last two years a number of bromo-addition products of benzothiazoles have been described in connection with the investigations of these compounds (*loc. cit.*) in which the bromine atoms unite with the nitrogen and sulphur atoms of the heterocylic nucleus; the hetero atoms concerned passing into their higher states of valency. Although this phenomenon is most strikingly exhibited by benzothiazoles, the existence of perbromides such as those of nicotine, pyridine, quinoline and dimethyl sulphide indicate that this type of unsaturation is quite common in organic compounds. In view of this it appeared of interest to examine the possibilities of inorganic compounds of sulphur and nitrogen in this connection, and the case of phosphorus pentasulphide appeared of unusual interest. Although indications of very loose combination between phosphorus pentasulphide and bromine have been obtained, no definite compound has so far been isolated, but since

these experiments are being continued, it appears desirable to publish this priority note.

EXPERIMENTAL.

Solvent.—The use of some non-hydroxylic solvent was obviously necessary. Carbon tetrachloride, diethyl ether, and chloroform were all examined, and the latter finally selected.

Phosphorus pentasulphide.—Kahlbaum's pure phosphorus pentasulphide was finely ground and kept in a vacuum desiccator over potassium hydroxide to remove traces of hydrogen sulphide and similar impurities which are always present.

Bromine. — The ordinary laboratory bromine was employed.

(A) Finely ground phosphorus pentasulphide was suspended in chloroform and bromine diluted with the same solvent added gradually from a burette with continuous shaking, and the resultant mixture scratched for some time, a certain amount of orange ill-defined crystals were isolated, which lost bromine very rapidly on exposure to air and were instantaneously reduced by sulphurous acid (*loc. cit.*) The quantity was too small for investigation.

(B) The above was repeated, using an excess of bromine, a dark red solution was obtained which fumed in moist air evolving hydrogen bromide, the solution was filtered from a residue into a crystallising dish, the solvent was then evaporated in a vacuum at room temperature (12° C.) in a sound vacuum desiccator. A small quantity of dark resinous material was obtained which could not be investigated.

(C) Phosphorus pentasulphide (2 gms) was suspended in 50 ccs. of chloroform which had been dried over phosphorus pentasulphide and fractionated before use, and bromine (10 mols) diluted with an equal volume of chloroform, gradually added as before; a slightly fuming liquid was obtained as before, the semi-red-coloured product was collected, and dried on a porous tile in vacuo, when it lost bromine, yielding unchanged phosphorus pentasulphide. Attempts were also made to brominate phosphorus pentasulphide in carbon disulphide, but these were as unsuccessful as the experiments described above. The action of iodine in chloroform on phosphorus pentasulphide is at present under investigation.

The Chemical Laboratory,
Highbury New Park, N.5.,

A FLUORESCENT DERIVATIVE OF β-NAPHTHOL.

By A. SAKOSCHANASKY, B.Sc.

The product formed from chloral hydrate and dimethylaniline in the presence of zinc chloride at comparatively low temperatures, when added to β-naphthol at about 200° in small quantities at a time, gives a product which is soluble in strong NaOH solution, giving a deep-red solution and is precipitated on the addition of water. This product is soluble in concentrated sulphuric acid, giving rise to a solution which is red by transmitted light and green by reflected light. Although most of the substance is precipitated on dilution, the flourescence is manifest, even in very dilute solutions. The substance in acid solution appears to be one of the most powerfully fluorescent known.

The product of the first reaction is an intermediate derivative in the preparation of dimethylparamidobenzaldehyde.

$$C_6H_4 < \begin{matrix} CH.(OH).\ C\ Cl_3 \\ N(CH_3)_2 \end{matrix}$$

$$= C_6H_4 < \begin{matrix} CHO \\ N(CH_3)_2 \end{matrix} + CHCl_3$$

Chloral hydrate acting alone on β-naphthol at high temperatures with evolution of HCl, gives a product which is soluble in dilute NaOH, and in concentrated H_2SO_4 without fluorescence (except the slight fluorescence due to naphol sulphonic acids). The alkaline solutions are blue, and yield a precipitate in contact with air.

General Notes.

UNITED STATES TRADE CONDITIONS.

Trade and industry in the United States are seasonally quiet, except in summer goods, which are very active, and the crop cable received by the London office of the Guaranty Trust Company of New York. Retail sales in May were slightly above those of the same month last year. Building contracts in May were 9 per cent. below those of April, but 18 per cent. above a year earlier.

The preliminary report for May gives exports at 370 million dollars., and imports

328 million dollars, both being below the figures for April, but above those of May, 1924. Cement production in May made a new record of 15,603,000 barrels, against 13,807,000 in April and 13,777,000 barrels in May last year. Stocks at the end of May were the lowest since January. Business failures in the week ended 18th June were 341, against 337 in the preceding week, and 409 a year ago. Professor Irving Fisher's commodity price index for the week ended 20th June was 158, against 156.9 in the preceding week and 157.2 a fortnight earlier. The Labour Department wholesale price index or May was 155.2, against 156.2 in April.

IMPERIAL INSTITUTE.

In accordance with the provisions of the Imperial Institute Act, 1925, which became operative on the 1st July last, the control of the administration and the management of the Imperial Institute was transferred on that date from the Secretary of State for the Colonies to the Parliamentary Secretary, Department of Overseas Trade, who became the responsible Minister under the Act.

The amalgamation of the Imperial Mineral Resources Bureau with the Imperial Institute was also effected on the 1st July. Henceforth all enquiries and correspondence relating to the work of tre Bureau should be addressed to the Imperial Institute (Mineral Resources Department), South Kensington, London, S.W.7.

SLICE CUT OUT OF HILL THAT STEPHENSON BORED.

A contract has been placed by the London Midland and Scottish Railway for the widening of a further 2½ miles of line between Walton and Snydale, near Wakefield, Yorkshire.

This is part of a big engineering task in which the L.M.S. are cutting a slice out of the hill through which runs the famous Chevet Tunnel constructed by Stephenson nearly 90 years ago, and exposing the permanent way to the open sky. When the work is completed the line will pass through what it is believed will be the deepest cutting in England. 95 feet deep and 90 yards wide across the top.

A new coal mine is being driven under the Chevet Tunnel and it was for reasons of safety that the L.M.S. engineers decided to dig away the hill. At the same time the opportunity was taken to widen the permanent way for a distance of four miles and lay two additional lines of rails.

The tunnel is 702 yards long on the main line from London to Leeds, and is covered by over 1,000,000 tons of earth and rock, which will have to be dug away before the brickwork of the tunnel is uncovered.

MORE NOTES ON ACOCANTHERINE.

By JAMES MOIR, M.A., D.Sc., and JOSEPH LEWIS, M.A., D.Sc.

(Journal of the South African Chemical Institute.)

Read November 25, 1924.

Extract.

Two entire plants of *Acokanthera venenta* (native name "Inhlunguneyba," or "inhlungunyemba") were received from the Magistrates of Eshowe (Zululand) and the Transkei (from Port St. John's), and were identified for us by the Botany Division in Pretoria.

The former of these plants was used up in establishing the extraordinary stability and toxicity of the glucoside acocantherine. 500 grams of the plant chopped up as a whole—leaves, root and stem—were boiled up with 6 litres of 30 per cent. alcohol; about 4 grams of sodium carbonate were added as the boiling proceeded, in the idea that acid hydrolysis of the glucoside would this be prevented. This gave an extract nearly neutral—pH about 6—but rather dark-coloured, and subsequent work has shown that the alkali is unnecessary, for acocantherine withstands boiling with very dilute acid. This is a great simplification of the process of extraction.

The extract had an extremely bitter taste, the same concentration, but contained no quite as powerful as that of strychnine in alkaloid. This extract, amounting to 5 litres, was boiled down (over the naked flame) to 1½ litres, whereby the alcohol was removed. 0.6 cc given to a guinea pig *per os* made it very ill, but did not kill it; but 1 cc. injected under the skin produced falling in two minutes and death in six minutes. This does is equivalent to 0.3 gram of the original plant taken as a whole, and from its rapid action is obviously far above the toxic dose. Acocantherine, therefore, contrary to what was previously

believed, withstands prolonged boiling of its equeous solution perfectly.

The poisonous fluid was treated with 2 gm. lead acetate, and the filtrate was then practically free from tannins (and was also free from soluble lead). It was taken to a syrup, mixed with sand, and rubbed up with alcohol. This was again taken to a syrup and rubbed up with hot 98 per cent. alcohol. The extract was allowed to cool, decanted from deposited gum, and again taken to dryness. It was then dissolved in water and excess ammonium sulphate added—which, according to previous writers, is supposed to precipitate acocantherine—and the precipitate was dissolved in water and again brought down by Am_2SO_4. The precipitate was a yellow gum, exceedingly bitter, and giving the absorption spectrum described in Part I. in concentrated H_2SO_4 solution. The colour in H_2SO_4 is brownish salmon-orange, and the fluorescence is strong. A minute dose of this given to a guinea-pig did not kill as expected. We infer that Am_2SO_4 does not give a satisfactory precipitation of acocantherine, but simultaneously precipitates the impurities.

PULVERISED FUEL.

The Latest Developments Considered along with Low Temperature Carbonisation, in Relation to the Mining Industries.

By David Brownlie. B.Sc. (Hons.) Lond., F.C.S., M.I.Chem.E., A.M.I.Min.E., etc.

Read before the Manchester Geological and Mining Society, on May 12, 1925.

(*Continued from Page* 24.)

Increased Thermal Efficiency.

The continuous thermal efficiency of steam generation that is being obtained by means of pulverised fuel firing can only be described as a revolution. We have seen that the guarantees alone in a number of cases are over 86%, whilst at Cleveland, 87% is being obtained, with as high as 92.9% for single 24-hour tests.

The original "super efficiency" station—Lakeside—is running at 85% all the year round and before this installation started up, very few power station boiler plants were running at 72-75% and the most efficient station in the world was at Colfax, at 75-76%.

The detailed performance figures for 9 months of 1923 at Lakeside are given in Table (7) reproduced from the 1923-1924 Serial Report on Pulverised Fuel of the Technical National Section of the Prime Movers' Committee, New York. This does not include fixed and overhead charges, and it will be seen that the continuous monthly efficiency varies from 83.09—85.69%. In 1924, however, this figure was improved, and for six months averaged 84.74% over-all, whilst for steam periods, as apart from shut-downs and light load, the figure is 85.78%. This corresponds to 1.15 lbs. of coal per K.W. hour, which is a new record in power generation by means of condensing steam units, being 1 K.W. hour per 15,000 B.Th.U. The very highest grade performance has always been regarded as 17,500 B.Th.U., and as regards ordinary power station practice, the average figure for all the power stations of the United States is given as 2.2 lbs. of coal per K.W.

In Great Britain, according to the Report of the Electricity Commissioners, "Generation of Electricity in Great Britain: Year ending 31st March, 1924," 392 power stations consumed 7,561,991 tons of coal, with an average of 2.67 lbs. per K.W. hour, whilst the Newcastle-upon-Tyne Electric Supply Co., at their Carville B. station, were generating 1 K.W. for 1.81 lbs. of coal, and at North Tees for 1.67 lbs. The new Barton Station, Manchester, is stated to be 1.48 lbs. of coal per K.W., or 20.33% thermal efficiency, although detailed steam generation figures do not seem to be available, whereas, Dalmarnock, Glasgow, is 17.47%. But out of the 385 stations, 313 were running at 2.9 lbs of coal per K.W., or over, and 152 were actually over 5.0 lbs., a striking commentary on the squandering of coal that is going on even under the most favourable conditions.

Cahokia is at the present time running at about 17,000 B.Th.U. on very inferior coal, as already indicated, whilst the figure will be improved, and Trenton Channel is expected to give 15,500 B.Th. U., and figures for other American stations have already been given. But mechanical stoking as applied to large water-tube boilers is also making rapid strides, and, in fact, we seem to be within sight of 90% continuous boiler plant efficiency with both methods of firing.

What these figures mean is best indicated by considering the ordinary performance of the average boiler plant. I have already shown in a number of papers and publications, that as a result of 400 boiler plant

tests with which I have been associated during the last 15 years in 41 different industries, representing 1,513 boilers and a coal consumption of 3,250,000 tons of coal per annum, the average nett working efficiency of the boiler plants of Great Britain is 58%. The correct figure ought to se say 72½-75%, and this represents a loss of no less than 20,000,000 tons of coal per annum.

The boiler plant of the average power station to-day is not running at anything like 70% continuous efficiency, and is probably not much more than 65%, whilst comparatively few plants reach 75%. The average marine boiler plant efficiency is probably less than 53%, whilst as we shall discuss, colliery plants are 55.5%. It is staggering to reflect that if the 90,000,000 tons of coal now burnt per annum in stationary land boiler plants at 58% were operated under pulverised fuel conditions, as now running at 85%, the saving would be about 32,000,000 tons of coal every year, which will give some idea of the figures at stake in connection with the more efficient burning of coal.

It is very certain also, that the general conditions as regards boiler plant efficiency are no worse in Great Britain than in any other country, and the average figure, both in the United States and Germany is almost sure to be less than 60%. Probably something like 500,000,000 tons of coal per annum is being burnt in the stationary land boilers of the world, and 100,000,000 tons of this is wasted for lack of scientific methods.

Refuse Fuels.

The question of the utilisation of refuse fuels is naturally of primary importance to the colliery industry, and the Cahokia plant is therefore of particular significance. Pulverised fuel for the first time has enabled us to take practically any kind of fuel, except very low volatile anthracite and coke, and burn it at the highest efficiency, over 80% continuously, in any required amount so as to give in water-tube boilers an evaporation equal to the normal figures with good-class coal. That is to say if a colliery had a material of 50% ash and 25% water, this could still be utilised on, say, a 50,000 lb. per hour evaporation boiler and give this evaporation merely by increasing the amount of fuel passing through the burners. Mechanical stokers will not do this to the same extent, because they become clogged up with ash and clinker and all kinds of complications occur, such as the volatile content and the sulphur. A considerable number of pulverised fuel plants are now beginning to be put down for refuse fuels. This is to burn what is known as "bone" coal, now thrown away as refuse, and is to supply power under the difficult conditions of driving electric railways in which the peaked loads are very severe.

At the present time a "Lopulco" plant is being installed at the McCalls Ferry on the Susquehanna River, for the Pennsylvania Water and Power Company, where it is intended to burn anthracite refuse dredged up from the Susquehanna River above the dam. This material averages in the dry condition 15% ash, which includes some sand, and has about 4½-5% volatile matter. Another low-grade fuel which is to be burnt by this method is Texas lignite, a plant now being in course of erection for this purpose in Trinidad for the Electric Bond and Share Company. In this case the raw fuel averages about 28-30% moisture and will be partially dried down to 15-20% before passing to the furnaces, while the ash content is low.

There is no question, also, that some unit pulverisers have very considerable possibilities in the way of burning colliery refuse fuels, even if the thermal efficiency of the boiler plant is not very high. Thus, according to an article in the "Iron and Coal Trades Review," 13th March, 1925, refuse anthracite duff is being burnt at the Pantyffnnon colliery of the Blaina Colliery Company in Carmarthenshire, with a "Simon-Carves" unit pulveriser equipment applied to a small "Stirling" boiler. This is designed for 6,000 lbs per hour evaporation, and with anthracite duff, this is stated to be maintained at 7,000 lbs. per hour running at 58% efficiency.

In Germany, lignite is now being burnt in a pulverised condition for furnaces at the steel works of the A. G. Becker Company, the consumption being 450 tons per day, as described in an article in "Stahl und Eisen," 22 March, 1923. In this case the raw lignite as mined, is crushed and dried in long rotating cylindrical driers, from 60% moisture down to 15%. It is then pulverised to a fineness of 15-30%, remaining on a 4,900 mesh per square centimetre, and is stated to be giving excellent results, furnaces having been in operation for eleven months. As fired, the analysis is roughly

50% volatile matter, 5.9% ash, and 12-18% moisture, with a heating value of B.Th.U. per lb. (4,500-4,800 calories). The temperature of the flame using cold air is stated to vary from 2,700-3,000° F. whereas with air preheated to 320° F., the furnace temperature rises to 3,150° F.

TABLE I.

COST OF STEAM PRODUCTION—LAKESIDE STATION, MILWAUKEE, WIS.
Year 1923.

	January	February	March	April
Coal.				
1. Tons of Coal consumed	20,191	19,811	19,092	19,080
2. Per Cent Moisture...	7.37	11.70	8.87	9.24
3. Per Cent Ash	11.28	12.60	11.24	11.70
4. Per Cent Sulphur...	2.07	3.10	1.79	2.08
5. B.T.U. per Lb. as Received ...	11,950	10,888	11,516	11,422
Steam.				
6. 1,000 Pounds of Steam Generated	336,441	299,078	305,714	302,660
7. Steam Pressure lbs. Absolute ...	287	289	302	301
8. Superheat Degrees Fahr. ...	185	185	185	189
9. Feed Water Temp. Degs. Fahr....	136	135	136	137
Efficiency.				
10. Per Cent of Boiler Rating ...	197.1	189.5	183.9	187.5
11. Per cent Combined Efficiency of Boiler, Furnace, Superheater & Economiser Overall	84.12	83.75	83.98	83.84
12. Per Cent. Combined Efficiency of Boiler, Furnace, Superheater & Economiser during Steaming Period.	84.92	84.47	84.97	84.80
13. Per Cent. the Banked Boiler Hours are of the Total Boiler Hours on Header	21.35	18.40	19.71	19.55

	May	June	July	August	September
Coal.					
1. As Above	19,685	18,025	18,076	19,196	19,285
2. Per Cent. Moisture ...	10.39	9.35	11.26	11.55	11.61
3. Per Cent. Ash ...	8.91	8.60	4.41	4.66	5.46
4. As Above	1.92	2.41	1.95	2.09	2.05
5. As Above	11,528	11,718	12,521	12,305	12,194
Steam.					
6. As Above	313,145	300,592	324,404	332,886	335,949
7. ,, ...	301	305	310	309	312
8. ,, ...	184	182	183	187	187
9. ,, ...	139	141	147	156	154
Efficiency.					
10. As Above	194.1	193.8	193.6	221.6	203.9
11. ,, ...	83.09	85.51	85.69	83.86	85.13
12. ,, ...	84.03	86.63	86.81	84.87	86.17
13 ,, ...	19.06	19.74	19.74	19.57	20.32

Cost per 1,000 lb. steam from and at 212° F. adjusted to a labour rate of 75c. per man hour, a coal cost of 22s. per million B.T.U., and a boiler rating of 175%

14.	Total Operating Labour ...	0.023
15.	Total Maintenance Labour ...	0.010
16.	Total Maintenance Material ...	0.009
17.	Total Supplies and Expenses	0.001
18.	Total Lubrication	0.001
19.	Total Fuel for Steam	0.244
	Total	$0.288

NOTE.—The above figures cover from the car dumper to the ash dump and include maintenance of boiler and pulverising room buildings, fixtures and grounds. Coal for banking is included in the fuel for steam cost.

APPLICATION OF PULVERISED FUEL TO THE COLLIERY INDUSTRY.

It will be agreed, therefore, that the progress made by pulverised fuel firing for steam generation during the previous 3 or 4 years, and even in the last twelve months. is of an unprecedented character. In consequence, the most careful consideration on the part of the mining industry is certainly necessary as to whether it would not be a paying proposition on the part of the larger collieries to install water-tube boilers and complete accessory plant, especially in connection with the treatment of the feed-water, along with pulverised fuel firing. This would effect a very great economy because of the much increased thermal efficiency and the fact that almost every kind of refuse material could be burnt, even with 50% ash.

I am sure that up-to-date mining engineers will agree with me that the present methods of steam generation at collieries are simply deplorable, even if not so very much worse than some other industries, such as iron and steel, for example. I have dealt with this subject at some considerable length in a contribution, "The Performance of Colliery Steam Boiler Plants and the Saving to be Obtained by their Reorganisation," published in *Engineering*, 25th July, and 1st August, 1919. Expressing the matter as briefly as possible, this gives the detailed working figures of 100 different colliery boiler plants, representing twelve years' work, and a total of 570 boilers and a coal consumption of 1,250,000 tons per annum. The plants were of all sizes, from 1 boiler with a coal consumption of 650 tons per annum, to 34 boilers, with 70,000 tons, and they are situated (the numbers being bracketted) in the coal fields of Derbyshire (8), Gloucestershire (1), Lancashire (14), Notts (7), Shropshire (1), Scotland (8), South Wales (17), Staffs. (26), Warwickshire (1), and Yorkshire (17). The tests in each case were of the most elaborate character, with a special battery of instruments, including, apart from laboratory work, feed water meter for the complete range of boilers under consideration, CO_2 recorder, apparatus for determining the amount of steam used by nozzles, pyrometers and draught gauges, and were corried out for the duration man shift and also for one week as a check, with the plant, of course, running under the normal every-day conditions. The final result was that the average nett working efficiency of this representative and large number of tests is 55.5%. Also the highest figure was 71.8%, and the lowest 32.5%, the latter being an installation of egg-ended boilers, and as showing the difference between individual colliery boiler plants the figures classify as follows:—

100 COLLIERY BOILER PLANTS.
Nett Working Efficiency.

1.	65% and over	5
2.	60% and over	9
3.	55% and over	29
4.	50% and over	22
5.	Below 50%	35
		100

For comparison, three representative industries are given below.—

	100 Collieries.	60 Chemical Works.	65 Dyeing etc. Works.	40 Paper Mills.
Total coal bill per annum on tests, tons	1,250,000	620,000	275,637	291,145
Average nett working efficiency ...	55.5%	57.9%	61.4%	65.0 65.0%
1. 80% and over	0	0	1	0
2. 75% and over	0	4	0	1
3. 70% and over	1	3	4	1
4. 65% and over	4	12	12	6
5 60% and over	9	9	14	7
6. 55% and over	29	13	12	10
7. 50% and over	22	9	10	8
8. Below 50%	35	10	6	7

(To be continued.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society held on Thursday, 11 June, 1925, resolutions were adopted reducing the annual subscriptions of Fellows and Members to £2 2s. and £1 1s. respectively, and abolishing the entrance fees for all classes of membership. These reductions will become effective on January 1 next. The president explained that the Council had decided to make these reductions in the hope that the membership of the Society would be increased by entrance into it of a large number of the members of the ophthalmic section of the profession and of the junior workers in all branches.

A paper by Mr. E. F. Fincham on "The Changes in the Form of the Crystalline Lens in Accommodation," was read and discussed. The most important existing theories of the mechanism of the accommodation of the eye are directly opposed in that they assign differently the effect of the ciliary muscle in the production of the change in the form of the crystalline lens. The theory of Helmholtz, which is the more universally accepted, states that the lens swells and increases in convexity during accommodation because the tension upon it is relaxed when the ciliary muscle contracts.

In order to explain the change of the anterior surface of the lens to a hyperbolic form in accommodation, Tscherning has propounded a theory in which the tension of the lens is maintained when the muscle contracts, and the forms of the surfaces are altered by a pressure by the vitreous humour exerted upon the periphery of the posterior lens surface.

This paper describes the measurement of the radii of curvature of both anterior and posterior surfaces of the lens, and also the movement which the apices of these surfaces make in accommodation. In two selected cases of men of the same age and having the same refractive error, considerable differences in the behaviour of the lens in accommodation were found. The results show that for a given amount of accommodation, whereas the lens surfaces in one case are more increased in curvature than in the other, their apices suffer less movement. It was also found that the surface which was most altered in curature shvowed the most pronounced hyperbolic form in both relaxed and accommodated conditions. The elastic property of the lens capsule and its variations in thickness are described. The changes in the form of the lens surfaces and the differences which occur in the lenses of different individuals in accommodation are explained upon the assumption of the Helmholtz theory, by taking into account the properties of the lens capsule.

A paper on "The Optical Properties of Amethyst Quartz," by Professor C. V. Raman, F.R.S., and K. Banerji, of Calcutta University, was read in abstract. A section-plate of amethyst cut normal to the optic axis, when viewed under suitable conditions, without a polariser or analyser, shows cololoured diffraction fringes, of the Fresnel type, arranged periodically and running parallel to the lines of the structure. The diffraction effect is due to the periodic change of phase produced by the structure and not to any periodic variation of transparency. The diffraction spectra of the Fraunhofer type due to the structure may also be obsercdv. Since a section-plate of amethyst quartz is thus in effect a phase-change diffraction grating, its appearance in the polariscope may be interpreted in the light of the Abbe theory of microscopic vision and in fact furnished very convenient illustrations of that theory.

Dr. R. S. Clay and Mr. Thomas H. Court exhibited a Lucernal Microscope by Samuel Washbourn, London. The instrument, which was probably made in 1800, is provided with adjustments for focussing, and for moving the object in two directions at right angles to one another. The objectives, consisting of single lenses, are mounted in a vertical slide so that different powers may be used. All the adjustments can e made from the eyepiece end. The instrument can readily be taken to pieces and the parts fit into a case, a fact which suggests that it was originally used by a peripatetic lecturer.

Messrs. The Thermal Syndicate, Ltd., exhibited samples of their pure fused quartz ware. The exhibit included a selection of transparent and opaque fure fused quartz apparatus and laboratory equipment; atmospheric and evacuated types of mercury vapour lamps for medical and research work; hypodermic syringes for flame sterilization; condensation pumps; tungsten filament lamps with quartz bulbs; bars for electric heaters or resistors; optical quality pure fused quartz plates and lenses.

ROYAL INSTITUTION.

A general Meeting of the Members of the Royal Institution was held on the afternoon of July 6, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair.

The special thanks of the members were returned to the Delegacy of the City and Guilds (Engineering) College for their valuable gift of a micro-photographic apparatus.

Mrs. Romanes and Dr. R. A. Young were elected Members.

New Patents.

This list is specially compiled for *The Chemical News* by Rayner and Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

16590.—Classen, A.—Manufacture of cellulose containing solutions. June 27th.

16099.—Ketoid Co.—Method of making acetylsalicylic acid. June 22nd.

16,083.—Badische Anilin and Soda Fabrik. Manufacture of a calcium nitrate fertiliser. June 22nd.

Specifications Published this Week.

211,488.—Freeman, H., and Canada Carbide Co., Ltd.—Manufacture of sodium sulphide.

212,238.—Governors of the University of Toronto.—Manufacture of antidiabetic products.

221,229.—Synthetic Ammonia & Nitrates, Ltd.—Methods of and apparatus for synthesis of ammonia.

222,486.—Deutsche Gasgluhlicht-Auer Ges.—Manufacture of pure zirconium compounds.

232,189.—Aluminium Co. of America.—Electrolytic production of aluminium.

Abstract Published this Week.

233,377.—Vaccines.—Toenniessen, E., 10. Ratsbergerstrasse, Erlangen, Germany.

An albuminous substance to be injected for diagnostic and theropeutic purposes is obtained from tubercule bacilli, freed from culture medium, by heating them in dilute hydrochloric acid, separating the bacilli therefrom, extracting them with dilute alkali solution, and precipitating the dissolved substance from solution by the addition of acetic acid. The separated substance may be purified by redissolving in alkali and reprecipitation by acetic acid, and may be dried by alcohol and ether. The preliminary treatment with acid, which may be followed by the addition of alkali and reacidification before separation of the bacilli for extraction with alkali, is stated to separate nucleic acid from the nucleo-proteids and to render permeable the waxy coating of the bacilli.

Messrs. Rayner and Co., will obtain printed copies of the published specifications only, and forward on post free for the price of 1s. 6d. each.

The Latest TRADE MARKS

The following list of latest Trade Marks Published, is specially prepared for "*The Chemical News*," by Messrs. Rayner and Co., Regd. Patent and Trade Mark Agents, of 5, Chancery Lane, London, who will give all information free regarding the Registration of British and Foreign Trade Marks.

ZINCAZOL.

456,477.—Chemical Substance for use as Accelerating Agents in the Vulcanization of India Rubber.—Ernest Smith, Paget Street Works, Paget Street, Collyhurst, Manchester. June 24th, 1925.

STYGIAN.

458,395.—Chemical Substances used in Manufactures, Philosophical Research, or Photography and Anticorrosives, but not including Size or Substances of a like kind to Size.—G. H. Brotchie and Co., Ltd., 32, Fenchurch Street, London, E.C.3. June 24th, 1925.

KAMFORITE.

B148,918.—A Chemical Preparation for use as an Insecticide and Fertiliser.—Charles Turney Hensman, trading as Hensman Brothers, Masonic Buildings, Bank Street, Horncastle. June 24th ,1925.

FORTIFER.

458,079.—Chemical Substances prepared for use in Medicine and Pharmacy.—Chemische Kerke Vormals H. and E. Albert, 24, Biebricherstrasse, Amoneburg, near Biebrich-on-Rhine, Germany. June 24th, 1925.

CYKLORAN.

457,531.—Chemical Substances used in Manufactures. — The Hexoran Co., Ltd., 68, Major Street, Manchester. uly 1st, 1925.

DUROIL.

459,217.—Anti-corrosives.—William Briggs and Sons, Ltd., 5, Cowgate, Dundee, Scotland. July 1st, 1925.

ARSENOSTAB.

458,620.—Chemical Substances prepared for use in Medicine and Pharmacy.—Boots' Pure Drug Co., Ltd., 37, Station Street, Nottingham. July 1st, 1925.

The above Marks have been "accepted" by H.M. Patent Office, and unless any objection is lodged, the Marks will be duly Registered. They are, however, officially advertised for opposition, which must be lodged within one month from date quoted. All particulars and forms for opposition will be sent free by Messrs. Rayner and Co., 5, Chancery Lane, London.

THE CHEMICAL NEWS,

VOL. CXXXI. No. 3405.

MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

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PREPARATION OF SOME NAPHTHALENE DERIVATIVES.

By MUNENARI TANAKA.

The substances described in the following communication had already been prepared by the author two years ago.

A.—1-*iodo-4-naphtholethyl-ether.*

This compound was prepared first from α-naphtholethyl-ether, which was sulphonated according to the method of Witt and Herrmann (Witt and Schneider, *Ber.*, XXXIV, 3173) nitrated (Witt and Schneider, *ibid.*, p. 3188) and then reduced (Herrmann, *J. f. pr. Ch.* XLV., 545). The 1-amino-4-naphthol-ethyl-ether thus obtained was diazotised and iodinated. 2.5 grs. of 1-amino-4-naphtholether hydrochloride (m.p. 275°) were dissolved in 15 grs. of absolute alcohol and saturated with dry hydrochloric acid gas until a strong acid reaction was given. Whilst well cooled, 10 ccm. of absolute alcohol containing 2.5 grs. of amyl nitrite were added. The temperature of the mixture was kept below 15° C. A deep green colouration of the mixture appeared, which changed finally to brown. The mixture was then warmed to 40° C., and again cooled in ice. The addition of a large quantity of ether caused yellow crystals to be deposited. This diazotisation product was then dissolved in a small amount of water, the theoretical quantity of potassium iodide solution slowly added, and the mixture finally warmed on a water bath until the evolution of nitrogen ceased. A dark oil remained which soon became solid. A solution of the oil in sodium hydroxide was then made and extracted with ether. The ethereal extract was washed with water, dried over sodium sulphate, evaporated, and the residue twice crystallised from methyl alcohol. Beautiful white needles were obtained which quickly turned brown in contact with air. M.P. 43.5° C.

SPECIAL NOTICE.

All MSS., Books for Review, Business Letters and Communications of every description should be sent to the offices as under, and not to any other address.

CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

Analysis. 0.1000 gr. substance gives 0.0804 gr. AgI.

Percentage of Iodine in $C_{12}H_{11}OI$:
Calculated, I = 42.6%. Found, I = 42.6%.

The above method is very lengthy and gives only a poor yield. The same substance has been obtained by the direct iodination of α-naphtholethyl-ether by iodic acid (Lassar-Cohn, p. 486). 12 grs. of iodine were dissolved in boiling glacial acetic acid and 4.2 grs. of iodic acid in 15 ccs. of water, and then 18 grs. of α-naphthol-ether were added. After being boiled for 40 minutes, the reaction was complete. On cooling, a dark oil separated out which was mixed with a small amount of bisulphate and then extracted with ether. The ethereal extract was then washed with water, dried over sodium sulphate, evaporated, and the residue crystallised from methyl alcohol.

The properties of this substance were exactly similar to those of the substance mentioned above. M.P. 43.5° C.

Analysis. 0.2029 grs. substance gave 0.1599 grs. AgI.

Percentage of Iodine in $C_{12}H_{11}OI$:
Calculated, 42.6%. Found, 42.6%.

B.—*5-nitro-4'-ethoxy-1, 1'-dinaphthyl.*

10 grs. 1-iodo-5-nitro-naphthalene. 15 grs. 1,4-iodo-naphtholethylether (large excess), and 20 grs. copper powder were heated together in a stream of carbon di-oxide to 220° C. (bath temperature. The internal temperature suddenly rose to 300° C., whilst the bath temperature remained at 220° C. The reaction was completed instantaneously. The temperature was then kept constant—at 220°-230° C.—for 15 minutes. The product was then ground with benzene, filtered, washed with alcohol and dried. The mass was then placed in boiling benzene and heated with animal charcoal. By concentrating the filtrate the di-naphthol compound crystallised out. By re-crystallisation from glacial acetic acid, clear brown plates, melting at 223° C. were obtained,

Yield: 5 grs.

Analysis. * 2.710 mgrs. substance gave 0.0875 ccm. N. Temp = 22° C.

Bar = 758 mm.

Calculated for $C_{22}H_{17}NO$	Found
N = 4.06%.	N = 3.64%.

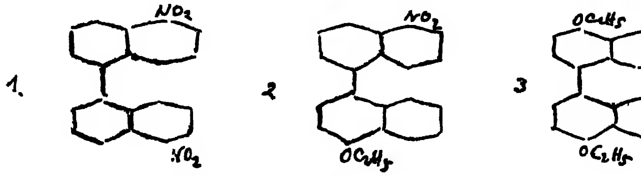
It cannot be deduced from this analysis whether or not the pure substance is obtained, since, from the condensation of 1-iodo-5-nitronaphthalene and 1-iodo-4-naphtho-methyl-ether three different products are conceivable, viz.:—

1.—5,5′-dinitro-1,1′-dinaphthyl (Scholl, *Monatsh.* XLII, 707),

2.—5-nitro-4-ethoxy-1,1′dinophthyl, and

3.—4,4′-diethoxy-1,1′dinaphthyl (Scholl, *Centralblatt*, 1922, III., 720).

Further experiments on this condensation are therefore being performed.



VALENCY RELATIONS: AN ELEMENT OF ATOMIC NUMBER ZERO WITH AN ATOMIC WEIGHT OF UNITY.

By F. H. Loring.

Sir E. Rutherford has indulged in a speculation on the possibility of an electron combining so closely with a proton as to produce an atom of remarkable properties, for he said: "Under some conditions, however, it may be possible for an electron to combine much more closely with the H-nucleus (proton), forming a kind of neutral doublet. Such an atom would have novel properties. Its external field would be practically zero, except very close up to the nucleus, and in consequence it should be able to move freely through matter. Its presence would probably be difficult to detect by the spectroscope, and it may be impossible to confine it in a sealed vessel."—*Roy. Soc. Proc.*, 1920, A97, p. 374.

From the following constructions it will be seen that there is no reason why an element immediately preceding hydrogen should not exist and that it might have an atomic number of nought and an atomic weight of one on the basis of oxygen sixteen.

If it be assumed that the electron, *e*, and the proton, *p*, stand just outside the element series proper, or, rather, that they stand as initial members of the sequence-series beginning with the zero element, then Diagram I. seems suggestive in this connection.

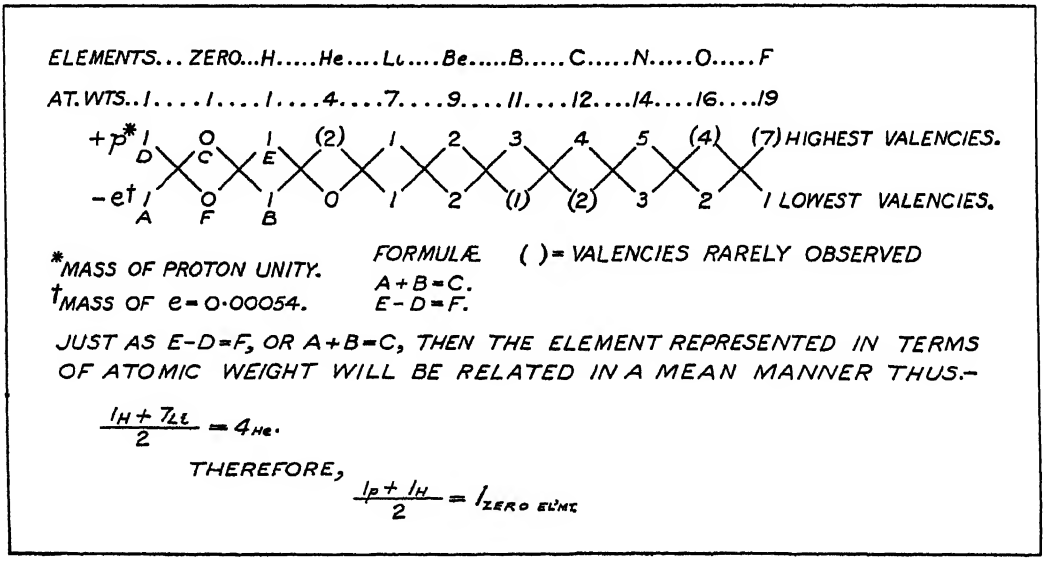


Diagram I.

The atomic-weight equation applies throughout the series ending with fluorine, only fractional variations existing where the agreement is not practicaly perfect. A cross relationship is thus suggested, as indicated by the valency scheme explained in connection with the diagram.

When the valencies are numerically alike for a given element it is suggested that they may be taken to indicate that the highest valency equals the lowest valency; or, in other words, there is only one normal valency. The idea of introducing negative valencies (polarities) throughout the scheme is not considered here.

The valency construction of Diagram I. can be extended so as to include all the elements, except those from praseodymium to lutecium inclusive, as the 13 elements here involved are not yet studied in connection with the scheme. This is shown by Diagram II. In this diagram, the indented line *a* shows the valency pairs taken in the step calculations according to the rule given under Diagram I. Incidentally, it is to be noted that the series closes symmetrically at 93.

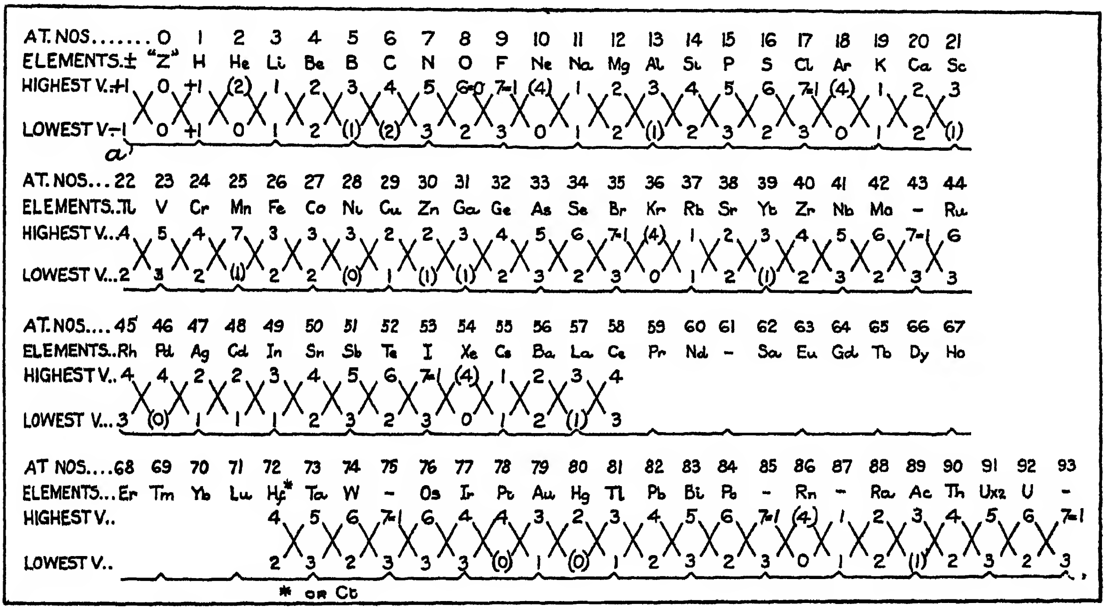


Diagram II.

It is perhaps significant that in Diagram II., oxygen can be written 6 = 0. Throughout the series some of the values, 6 and 7, seem to be consistently reducible by regarding 6 as a limit and counting above 6 as a new series, 0, 1, 2, etc. The figures enclosed in round brackets ( ) are taken as rare. The first element of this kind is helium. If one could consider the helium atom minus two electrons (= alpha particle) as having a valency of 2, this element would seem to fit properly into the series. On this basis, if neon lost four electrons, its valency would be 4 as indicated, but this would be a rare occurrence. Nickel, palladium, and platinum, which are analogous in the ordinary periodic classification, appear to have a minimum valency of 0, so that their working values may be (1) 2, 3, or 2, 4, as the case may be. Zinc with a minimum of 1 is unusual, but as the scheme deals with extreme values, sometimes very rare, this feature may be allowed. The zero values obtained by deducting the left-hand value from the right-hand one, according to the rule, leads to 2 minus 3 being put down as 0, as in the case of nickel. If the figures are reversed in taking the difference, then 3 minus 2 = 1. Boron appears to be monovalent in B_3N. The mass of the proton is taken as about unity, which is customary, the scale being O = 16.

The accompanying table is drawn up so as to show at a glance the extreme valencies of Diagram II., intermediate valencies as seem necessary, and the values given by

J. N. Friend in his book, "Theory of Valency," 1909 or 1915. It wil be seen that the Diagrams agree very well with the standard values as given by Friend. It is to be noted that if a change is made it affects several adjoining values.

Elmt.	Extreme Valencies	Inter Valencies	Friend's Selection
"Z"	0		
H	1		1
He	0, (2)		0
Li	1		1
Be	2		2
B	(1), 3,		3, 5*
C	(2), 4,	(3)	2, 4
N	3, 5,	(4)	3, (4), 5
O	2, (4),		2, (4)
F	1, 3,		1, 3
Ne	0, (4),		0
Na	1		1
Mg	2		2
Al	(1), 3,		3
Si	2, 4,		4
P	3, 5,		3, 5,
S	2, 6,	4	2, 4, 6
Cl	1, 3, 7		1, 3, 7
Ar	0, (4),		0
K	1		1
Ca	2		2
Sc	(1), 3		
Ti	2, 4,	3	4
V	3, 5,	4	
Cr	2, 4,	3	2, 3, 4, 6?
Mn	(1), 7,	2, 3,	2, 3, 7
Fe	2, 3,		2, 3
Co	2, 3,		2, 3
Ni	(0), 3	2	2
Cu	1, 2,		1, 2,
Zn	(1), 2,		2
Ga	(1), 3,	2	2, 3
Ge	2, 4,		4
As	3, 5,		3, 5
Se	2, 6,	4	2, 4, 6
Br	1, 3, (7)		1, 3
Kr	0, (4),		0
Rb	1		1
Sr	2		2
Yt	(1), 3,	2	
Zr	2, 4,		4
Nb	3, 5,		
Mo	2, 6,	3, 4, 5,	2, 3, 4, 5, 6
—	1, 3, 7,		
Ru	3, 6,		6, 7? 8?
Rh	3, 4,		
Pd	(0), 4,	2	2, 4
Ag	1, 2,		1, 2
Cd	1, 2.		1, 2
In	1, 3,	2	1, 2, 3
Sn	2, 4,		2, 4
Sb	3, 5,	4	3, 4, 5
Te	2, 6,		2, 4, 6
I	1, 3, 7,		1, 3, 5
Xe	0, (4)		0
Cs	1,		1
Ba	2,		2
La	(1), 3,		
Ce	3, 4,		3, 4
...	...	...	...
Hf	2, 4,		
Ta	3, 5,		
W	2, 6,	3, 4, 5,	2, 3, 4, 5, 6
—	1, 3, 7,		
Os	3, 6,		6, 8?
Ir	3, 4,		3, 4, 6
Pt	(0), 4,	2	2, 4
Au	1, 3,		1, 3
Hg	(0), 2	1	1, 2
Tl	1, 3,		1, 3
Pb	2, 4,		1, 2, 4
Bi	3, 5,		2, 3, 5
Po	2, 6,		
—	1, 3, 7,		
Rn	0, (4),		0
—	1		
Ra	2		2
Ac	(1), 3,		
Th	2, 4,		4
U	2, 6,		

* In $B(CH_3)_3$ KOH oxygen may have a valency of 4, in which case B would be trivalent if the bond joining one CH_3 to B were intercepted by O. Similarly, NH_3 could take the place of KOH, N like O intercepting one CH_3 to B bond and exercising its highest valency of 5.—F. H. L.

The writer here takes the opportunity of acknowledging J. G. F. Druce's assistance in pointing out certain compounds that fit into this improved valency series.

INDUSTRIAL ADVANCE IN SPAIN.

In his report dated March last, Capt. U. de B. Charles, British Commercial Secretary in Madrid, points out that industry in Spain has very considerably advanced during recent years. To-day there are few manufactured goods which Spain does not produce, whereas before the war her manufactures were limited to a few lines. This change has been accompanied by a system of high protection.

PULVERISED FUEL.

THE LATEST DEVELOPMENTS CONSIDERED ALONG WITH LOW TEMPERATURE CARBONISATION, IN RELATION TO THE MINING INDUSTRIES.

By DAVID BROWNLIE, B.Sc. (Hons.) Lond., F.C.S., M.I.Chem.E., A.M.I.Min.E., etc.

Read before the Manchester Geological and Mining Society, on May 12, 1925.

(*Continued from Page* 44.)

If we take the coal production of Great Britain in round numbers as 260,000,000 tons per annum, then the amount of coal burnt under colliery boiler plants is 17,500,000 tons, that is roughly 6¾%. So far as I am aware, no other information has ever been published concerning the operation of colliery boiler plants, except, of course, a large number of results of tests of individual installations, many of which, however, were carried out under purely abnormal conditions and do not relate to the ordinary working. I am convinced that 55.5% nett working efficiency is a fair average figure for the colliery boiler plants of Great Britain, and probably of every other country as well, especially since I have examined without testing at least an additional 100 plants. We can take it, therefore, at any rate until further information is available, that 17,500,000 tons of coal is being burnt every year by British collieries at 55.5% efficiency. If modern methods were adopted with the existing fuel and "Lancashire" boilers, this figure could be brought up to 70%, that is a saving of about 3,700,000 tons per annum. Already in the 100 plants, 5 are working at 65% or over, whilst a few installations are on the very latest principles, and it is rapidly becoming an impossible state of affairs that 85% of plants should be running at less than 50% efficiency.

As a result of the personal experience mentioned of at least 200 plants, the average colliery installation can be taken as follows:—

"Lancashire" boilers, hand firing, no feed-water economisers, no superheaters, chimney draught, defective coverings (including the long pipe circuits which have uncovered flanges, and the whole installation in the open air without a roof, and no scientific instruments for control, such as water meters, feed meters, automatic flue gas analysing machines. Also the feed-water is bad, giving rise to both scale and corrosion, no softening plant is used, but the exhaust of the winding engine is blown into the feed tank, giving hot water averaging about 160-180° F. at the boilers.

It is under these average conditions that 17,500,000 tons of coal are being burnt every year, and I must confess I have always been surprised the average steam generation is over 55%, especially since the figures for the whole country are only 58%, working under much more favourable conditions.

In connection with colliery boiler plants there is another question of the utmost importance, that is, the use of refuse and purely unsaleable coal. The comfortable view has always been held that the efficient operation of colliery plants does not matter because nothing but low grade fuel of no value is used. Thus, not so very long ago a prominent official in the colliery world stated that the efficiency of the burning of coal was a matter outside the industry altogether. This gentleman presumably either imagines that nothing but unsaleable coal is used, or has forgotten altogether that collieries are amongst the largest consumers of coal in the country, burning, for example, more than twice the amount used by all the electricity stations, and nearly as much as the coke oven and towns' gas industries.

These ideas are only a few of the very many examples of the extraordinary habit we have in Great Britain of steadfastly refusing to look industrial facts in the face and get down to figures. From my experience of observing the burning of about 2,500,000 tons of coal per annum on colliery boiler plants, I have no hesitation in stating that this idea of nothing but refuse fuels being burnt is entirely unwarranted. Incidentally, in the "Final Report of the Coal Consumption Committee (Ministry of Reconstruction)" issued a few years ago, the following statement occurs:—

> "The policy of collieries has been to set free the best qualities of coal for the market and to retain for colliery consumption the poorest quality. The return shows that the ash in some of the fuels used ranges from 50% to 80%."

This, in my opinion, is a grossly misleading statement, made without the slightest basis of fact or independent opinion. For example, the average ash content of the 1,250,000 tons of coal used per annum on the 100 tests was 15.5%, the worst figure being 37.8%, whilst the best was 6.1%. Also 78 plants out of 100 had ash of less

than 20%, and only 4 plants were over 30%. In fact, a true mathematical average of these 100 colliery boiler plants, compared with the figures for 400 boiler plants in 41 different industries is not so very much inferior to that supplied to steam users in general, the respective figures being for the past 12 years or so approximately 10,500 B.Th U., and 15.5% ash, as compared with about 11,800 B.Th.U. and 11 5% ash. Since the war, the average quality of coal supplied is, of course, much worse, and the ash content is certainly considerably more than 11.5%.

It is naturally very difficult to obtain authentic data as to what percentage of saleable coal is actually used by collieries. I can only give merely as an opinion, basied, however, on somewhat lengthy experience, that out of the 17,500,000 tons coal used per annum, something like 9,000,000 tons is high grade saleable coal, 5,500,000 tons is medium quality, equal to much that is now sold, and 3,000,000 tons—that is, 17%—is refuse. If the colliery industry would only adopt scientific methods in the burning of refuse coal on the existing "Lancashire" boilers, say, a modern type of steam jet furnace, or mechanical draught, with proper scientific control, a further 2,750,000 tons of saleable coal could be released, that is a total of 6,450,000 tons 3,700,000 plus 2,750,000) or 36% of the coal consumption. To take one example only, washery settlings are almost always thrown away in the settling "ponds," in spite of the fact that this material can quite easily be used for steam generation, as I know from my own experience.

The main point is, however, what could be done in the case of the larger collieries if water-tube boilers were installed and the latest scientific methods adopted, along with pulverised fuel firing. Incidentally, it is rather startling to reflect that if such methods could be undertaken throughout the colliery industry, and pulverised fuel plants run at, say, 82.5% efficiency on medium and refuse coals, instead of 9,000,000 tons of high grade coal, 5,500,000 tons of medium quality coal, and 3,000,000 tons of refuse being burnt every year at 55.5% efficiency, we should have for the same steam output, on the most conservative basis, a consumption of something like 5,500,000 tons of medium quality, and 9,500,000 tons of refuse at 82.5% efficiency. Or, in other words, the colliery industry would save the whole of the 9,000,000 tons of good coal per annum.

In practice, however, the correct method is for all the existing small and medium-sized "Lancashire" boiler plants to be modernised on the lines indicated, and brought up to 70% efficiency, whilst the larger plants should certainly in many cases adopt water-tube boilers. In this event, however, it is extremely difficult to say whether pulverised fuel or mechanical stoking is the best, and very much depends on the local conditions.

Probably because of the severe competition of pulverised fuel, mechanical stoking has made remarkable advances in the last year or two. We have now up-to-date stokers for water-tube boilers that are stated to burn refuse fuels up to 50% ash in a fine state of division, with an extremely low volatile content, even 5%. Also, as mentioned, highly efficient devices have been perfected, equally applicable, however, to pulverised fuel, such as the water-cooled "fin" side and back walls for the combustion chamber, through which the feed-water circulates, water or air-cooled brickwork, and modern suspension firebrick arches, giving a single arch or roof up to 30 feet in width or over, allowing single travelling grate stokers of this enormous sixe to be constructed, and the struggle for supremacy between the two methods of firing as regards electricity station working is stronger than ever.

Whichever of the two is superior for given conditions—and this paper is, of course, concerned primarily with pulverised fuel—there is no question that it is high time the colliery, as well as the iron and steel industries, woke up and began to think in terms of heat units.

Pulverised Fuel and Low Temperature Carbonisation.

As already indicated, the advent of pulverised fuel firing and the competitive methods and improved scientific principles of steam and power generation stimulated by its progress, is going to lead to an enormously reduced consumption of coal in Great Britain, and, in fact, if this does not happen as a result of a drastic reorganisation in our thermal operations in general, then we shall go under as an industrial nation of the first rank. It seems to be almost impossible to get the ordinary man, irrespective of his rank and position, to understand

the appalling inefficiency of our general methods of using raw coal, although a few of us have been crying it from the house tops for years. The position is so lamentable that it is difficult to give the plain facts without appearing to exaggerate, but on the most conservative basis, with the continued use of raw coal, this country could save with the greatest ease, 40,000,000 to 50,000,000 tons of coal every year, that is, say £50,000,000 to £75,000,000, simply by improving already existing methods and without spending millions of money on super-power station schemes. Out of the 260,000,000 tons of coal raised in Great Britain, about 75%—that is, 195,000,000 tons—is consumed at home, apart from marine work. Of this, something like 90,000,000 tons is used for stationary land boilers ,and it will be remembered that the 58% average nett working efficiency means that 20,000,000 tons every year could be saved in this direction alone, since the efficiency boiler plants in general ought to average 72.5 to 75.0%.

Further in connection with steam generation and utilisation, the average hardness of the boiler feed water in Great Britain seems to be about 11°, representing 2,000 tons of scale a week deposited in the boilers, and probably a loss of 5,000,000 tons of coal per annum. Lack of superheating, efficient covering of steam pipes, including the flanges, and condensation losses in general, probably represents another 5,000,000 tons. Many of the operations carried out in the iron and steel industries are so disgraceful that less than 10% thermal efficiency is commonplace, in spite of the fact that producer gas firing would give 20-25%. I know from my own personal experience of at least two large iron and steel concerns that were squandering 500 tons of the best quality coal per week on the boiler plant alone.

Again, another serious national waste of coal is represented by the fact that coke oven plants are fired, generally, in the crudest fashion, with the rich coke oven gas, instead of using, in many cases, according to circumstances, far cheaper producer gas. Again, the failure to utilise blast furnace gas on efficient lines, as carried out, for example, at the Ford factory, Detroit, is stated by some authorities to be causing a loss to British industries of 1,000,000 H.P.

The mustard trade may, perhaps, be allowed to be a remunerative proposition very largely because of what is thrown away on the plates, but most certainly the colliery industry cannot expect that Great Britain will go on squandering 40,000,000 to 50,000,000 tons of coal every year, and pulverised fuel firing is a significant warning of this fact. It has been stated that in 1924, £162,386,000 was available from the mines of Great Britain for profits and wages, practically all swallowed up by the latter, and a large part of even this inadequate revenue is simply dependant on the unscientific methods of the coal user, who, in consequence, is being faced with increasing difficulty in competing in the world's markets.

I suggest that the colliery concerns of this country should co-operate without a moment's delay, and concentrate on research and investigation work on low temperature carbonisation and similar methods for the scientific use of raw coal, and I can only say again that if a considerable sum had been spent in this way for, say, the last ten years in connection with the treatment of coal on scientific lines, the colliery industry to-day would have been in a powerful position, and we should also have been well on the way to producing all our own oil, instead of being at the mercy of other countries, thousands of miles away, for motor spirit and liquid fuel.

I am not going to attempt to give even the barest outlines of the huge subject of low temperature carbonisation and of the 80 processes and 1,000 patents already mentioned. The chief British processes are, however, as follows:—(1) British Oil and Fuel Conservative Co. ("Freeman" process); (2) "Fusion" Retort process; (3 Low Temperature Carbonisation, Ltd. ("Coalite"); (4) "Maclaurin" process; (5) Power Gas Corporation Process; (6) "Pure Coal Briquette" process (Sutcliffe Speakman & Co., Ltd.); (7) "Richards-Pringle" process; and (8) the "Tozer" process.

As is well known, a number of these are beginning at least to attract the notice of the colliery world, six of them now having plants under active construction, either directly for collieries or in such a way as to provide large-scale experience and operating data.

We are very near practical success to-day with more than one process in this country and abroad, and as already indicated, the perfection of pulverised fuel firing has greatly improved the possibilities because it means that all low temperature fuels can now be used at the highest efficiency for

general furnace work and especially steam generation.

If the coal industry seize their opportunity they wil be in a position to utilise low temperature carbonisation to the fullest extent for all grades of fuel, and in the first place secure an increase in revenue from gas, paraffinoid liquid products, sulphate of ammonia, and smokeless fuel, which would more than counterbalance the present depressing state of affairs and the greatly reduced demand that is bound to come. At the same time we should be able to produce in security in out own country, the whole of the liquid fuel we require, and a large part of the fixed nitrogen as well for the cultivation of the soil, this latter subject being even more important than national fuel economy.

A consideration of both pulverised fuel and low temperature carbonisation serves to remind us very forcibly that this country is suffering at any rate from three primary defects. The first is the failure to apply scientific methods and to appreciate either with money or regard, the scientific man. Secondly, we allow literally millions of acres of fertile soil to be literally derelict, whilst we spend over £300,000,000 per annum abroad for foodstuffs. Then, finally, there is the serious lack of the principle of co-operation and the tendency to try and stifle the man of independence and originality. The colliery industry is certainly better than the average in these latter respects, but the co-operative spirit from the point of view of research is almost entirely lacking. Present research work associated with collieries, for example, although admirable within its extremely limited extent, is like emptying barrels with a teaspoon. We see the spirit of antagonism to individual initiative at work in every direction, for example, in the utterly ridiculous attempts to prevent a man calling himself an architect,an engineer, or a civil engineer, the footling examinations held by certain scientific societies, and the proposed new Wireless Bill, in which it is coolly suggested that anyone who wishes to undertake independent research work in wireless must not only have a licence, but actually submit the programme of his purely private ideas and suggested investigations to a horde of Government officials.

The real pioneer of pulverised fuel was Thomas Crampton, a London electrical and civil engineer, who, between about 1868 and 1872, investigated the whole matter on scientific lines, and burnt over 2,000 tons of coal in a pulverised condition. However, he could not interest British industry in the matter. Incidentally, it may be mentioned that John Anderson, of Lakeside, is a Scotchman, born in Aberdeen, and the greater part of the scientific methods of control of boiler plants originated in Great Britain. We have got to alter all this, and mining ought to be one of the most prominent of all industries in taking the lead.

(To be continued.)

BRITISH EMPIRE EXHIBITION, 1925.

NOTES ON THE EXHIBITS.

(Continued.)

DYESTUFFS OF GREAT BRITAIN.—The Chemical Section this year shows considerable evidence of collective exhibits. Close by the Alchemist Gate is a very beautiful stand designed by Mr. Norman Wilkinson, on which are shown a number of exhibits illustrating in a charming manner the application of British dyestuffs to fabrics and materials of all descriptions. The uninteresting collection of bottles containing dyes has given place to a fascinating display of what results can be obtained by using British dyes alone. This is one of the exhibits which Her Majesty the Queen noted specially during her recent visit to Wembley. The stand has as its main features two tents and a long corridor in multicoloured drapings. The roofs of the tents, which bear the device, "Dyestuffs of Great Britain," continuously revolve slowly.

BRITISH TAR FOR BRITISH ROADS.—At the other end of the Chemical Hall near the Gate of Harmony, is a delightful country scene. A back cloth designed by Mr. Norman Wilkinson, leading down to a bridge in a country road, with a hospitable-looking inn on its right hand and on the left a very pretty garden. The road is made up with Tarmac, and advertises the use of British Tar on British Roads. The general public is much attracted to this stand, because there are in a tree in the garden, two birds-nests, complete with birds, which, thanks to some ingenious mechanism, are constantly in song.

CRYSTALS.—Near the A.B.C.M. office is an exhibit of Crystals, supplied by Messrs. J. and J. White ,Ltd., Peter Spence and Sons, Ltd., and British Cyanides, Ltd.

The crystals shown are, of course, alum, chromates and various cyanides. In a case near at hand are a number of fine chemicals prepared by Messrs. Johnson and Sons, Ltd.

SCIENTIFIC SECTION.—The object of the Scientific Section is briefly summarised by the captions over the three doors bearing the words, "Scientific Section—Coal and the National Welfare; Salt and the National Welfare; Food and the National Welfare." The centre of the hall is taken up by a pillar surrounded by a cauldron of coal. Around this are three show cases in which are various by-products obtained from coal.

SALT.—This exhibit starts outside the Scientific Section on a bench adjoining that of the Salt Union, Ltd. There is shown a model of a salt factory and leading from that through an exhibit prepared by Mr. T. V. Barker, dealing with crystallography, we come to a series of exhibits showing the uses and preparation of soda and chlorine, caustic soda and sodium carbonate, as well as of hydrochloric acid. The exhibits in this section have been obtained from the United Alkali Co., Ltd., the Castner-Keller Alkali Co., Ltd., Joseph Crosfield and Sons, Ltd., and Dr. Cross.

FOOD.—This section has been prepared by Mr. Page and Professor Drummond. It shows on the one hand various factors in the growth and preparation of food, and on the other its effect upon the composition. This exhibit, which is very adequately described by means of cards and tapes, tells its own tale very clearly.

BRYANT AND MAY, LTD., Stand No. A.30. —*A Tudor Cottage*.—Legitimately priding themselves upon their position as an old English firm, Messrs. Bryant and May, Ltd., of Bow, Liverpool, Garston, Leeds and Glasgow, appropriately house their exhibits in an Old English setting. A Tudor cottage has been selected as the best way of reflecting the general character of the business.

W. B. CARTWRIGHT LTD., Stand No. A.14.—Maunfacturing chemists, perfumers, and makers of Elfrida toilet preparations, etc. (Regd.)

CERNOLTINE, LTD., Stand No. A.59.—This firm show the Cernoline preparations, which are prepared from vegetable gums and juices, together with olive oil. The firm aim at selling contents of the pots, although the various preparations are well got up in jars with aluminium tops, and "Cellophane" wrappings and distinctive labels.

THE CLAYTON ANILINE CO., LTD., Stand No. A.11.—The discovery which led to the manufacture of aniline on a commercial scale gave the first impetus to the development of the colour industry. This was in the fifties of the last century, and in 1875 the Clayton Aniline Company Ltd., was founded for the manufacture principally of Aniline Oil and Salt.

THE BADMINTON DISTEMPER CURE CO., LTD., Stand No. A.7.—Distemper is a complex disease, the most dangerous of all maladies affecting the canine race. It is so devastating that several research committees have been instituted to arrive at some idea of its causes. This is a problem of the highest importance to all dog owners and breeders, who will be glad to learn that there is now on the market a successful cure, "Lintox," which is daily saving the lives of priceless animals and thus earning the gratitude of all dog owners all over the world.

General Notes.

COMMITTEE OF INDUSTRY AND TRADE.

The Committee on Industry and Trade, of which Sir Arthur Balfour, K.B.E., is Chairman, have prepared a survey of the conditions prevailing in the markets of the world which affect British export trade. This is published under the title, "Survey of Overseas Markets," by H.M. Stationery Office. The contents of the volume are mainly derived from official sources, and the Committee have prefixed an introduction, calling attention to certain important considerations arising from the survey. It is hoped that the volume will be of considerable service at the present juncture, when the condition of British industry and trade is the subject of so much discussion.

CANADA'S ASBESTOS INDUSTRY.

The High Commissioner for Canada in London has received from the Dominion

Department of Mines, information on asbestos, which has been prepared by Mr. A. H. A. Robinson, of the Mines Branch:

From small beginnings about 1880, Canada's asbestos industry has grown steadily until at the present time, exclusive of fuels and structural materials, it is in point of value the most important of her non-metallic mineral products. The value of the shipments of asbestos of all grades in Canada in 1924 amounted to nearly six and three quarter millions of dollars (£1,386,000.)

From its earliest days up to a few years ago, the growth of the Canadian asbestos industry had been remarkably steady and at a normal healthy rate. But, between 1917 and 1920, prics advanced so rapidly that crude sold as high as $3,000 (£616) per short ton; and, in 1920, output reached 200,000 short tons, valued at nearly $15,000,000 (£3,080,000). A slump in prices in 1921 caused production to fall off more than 100,00 short tons in quantity and nearly $10,000,000 (£2,053,000) in value. In 1923, 231,482 short tons were produced, but the value was only a little over half that of the 1920 output; in 1924 the production was some 225,744 short tons, valued at $6,710,830 (£1,377,800). The average price of crude is now about $300 (£62) per ton, or twice its pre-war value.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.

Following a highly successful conference held at High Leigh, Hoddesdon, in September ,1924, of those interested in Special Libraries and agencies for the collection, treatment and distribution of information, a representative Standing Committee was appointed to ensure continuity of the work and to arrange for a second conference. The Standing Committee has been fortunate in obtaining assistance from the Carnegie United Kingdom Trustees, and the proceedings of the first conference have just been issued.

The Committee has decided to name the body thus called into being, "The Association of Special Libraries and Information Bureaux."

The second conference of the Association will be held at Balliol College, Oxford, during the week-end 25th to 28th September, 1925; full particulars can be obtained from the Organising Secretary, at the offices of the Association, 38, Bloomsbury Square, London, W.C.1.

As accommodation is not unlimited, early application is advised, and in the event of restriction being necessary, preference will be given to the duly accredited representatives of organisations, whether scientific, commercial, industrial, social, political, or educational, concerned with the systematic use of sources of information.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920. APPLICATIONS FOR LICENCES IN JUNE, 1925.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during June has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 458, of which 364 were from merchants or importers. To these should be added 44 cases outstanding on the 30th May, making a total for the month of 502. These were dealt with as follows:—

Granted—328 (of which 293 were dealt with within 7 days of receipt).

Referred to British makers of similar products—100 (of which 67 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—25 (all dealt with within 2 days of receipt).

Outstanding on 30th June, 1925—49.

Of the total of 502 applications received, 385, or 77 per cent., were dealt with within 7 days of receipt.

WHOLESALE PRICES IN JUNE.

There was a further slight fall in the general level of wholesale prices last month, the index number being returned at 157.7, against 159.0 for May. The continuous decline for the past five months totals 13.4 points, or 7.8 per cent. The index number for June of last year was 162.6.

CANADIAN TRADE AND INDUSTRY.

Good crop reports from the West have been followed by an increase in manufacturing activity and a decrease in unemployment. Building construction is far in advance of that a year ago, and exports of pulp and paper have been larger.

NEW CAPITAL ISSUES IN FIRST HALF-YEAR.

According to Midland Bank statistics, new issues of capital in the first six months of the year amounted to £124,345,182, as compared with £106,215,409 in January-June, 1924, and £123,524,654 in the first half of 19232.

MERCHANT NAVIES OF THE WORLD.

In a review of Lloyd's Register of Shopping for 1925-26, the Board of Trade Journal shows the growth of the world's merchant tonnage during the past twelve months, since 1914 and since 1891. The reduction in sailing vessels, the increase of steam tonnage and motor-ships, and other other changes in types of vessels and of machinery are also surveyed.

BRITISH DRUG HOUSES, LTD.

We have to acknowledge receipt of a catalogue of fine chemical products, including organic and inorganic chemicals, analytial reagents, indicators, standard stains, etc., of the above well-known company. The catalogue is arranged in alphabetical order and the prices are given usually per oz., lb., and g. and kg.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

The Spatial Structure of cycloparaffins. Part I. A New Aspect of Mohr's Theory and the Isomerism of Decahydronaphthalene, by W. A. WIGHTMAN.

The dynamic possibilities of Sachse's two strain-free configurations of *cyclo*hexane are examined by the aid of specially constructed models. It is revealed that strainless motion, comprising co-ordinated relative rotation of the atoms about the bonds of the ring, is possible in one form, but not in the other, and the bearing of this discovery upon the isomerism of decahydronaphthalene and upon the possible existence of two forms of *cyclo*hexane is discussed.

Chenopodium Oil. Part II. The Hydrocarbon Fraction, by T. A. HENRY AND H. PAGET.

Chenopodium oil contains from 70 to 75% of an organic peroxide ,ascaridole, the remainder being *p*-cymene and terpenes. It is now shown that the lævorotatory component is *l*-limonene, and that the failure to identity it previously is due to the large amount of *p*-cymene present, and in part to the interference of a fourth constituent, which forms a tetrabromide, yielding a low melting, unstable mixture with *l*-limonene tetrabromide, and so prevents separation of the latter, unless it is removed prior to bromination. *l*-Limonene has now been identified by its tetrabromide, and the isolation of its characteristic oxidation products, among which is a new acid,

$$\mathrm{CH(OH)Me.SH_2.SH(CH_2.CO_2H).}$$
$$\mathrm{CH(OH).CO_2H}$$

The fourth constituent of the hydrocarbon fraction is present in minute quantity, is not separable from its associates, and has only been isolated in the form of its tetrabromide. From the latter an acetoxybromo derivative has been prepared, which on oxidation by chromic acid yields methyl *p*-tolyl ketone. Indirect evidence as to the nature of the new terpene has been obtained by the isolation from the products of oxidation of the whole hydrocarbon fraction of a hydroxy-ketone $C_{10}H_{16}O_2$, the semicarbazone of which readily loses a molecule of water forming a base $C_{11}H_{17}ON_3$ yielding characteristic crystalline salts.

Echitamine, by J. A. GOODSON AND T. A. HENRY.

The alkaloid echitamine, which has been known since 1875, has now been obtained from a new source, *Alstonia congensis*, and the opportunity has been taken to characterise the base and its principal salts, and to make a further examination of these products. The alkaloid, which has the formula $C_{22}H_{28}O_4N_2$, has not been obtained crystalline, but it yields a series of well-crystallised salts. It is a methyl ester, and is readily hydrolysed, yielding demethylechitamine $C_{21}H_{26}O_4N_2$. It contains a methylimino-group, and yields a diacetyl derivative and a nitroso-compound, both of which are well crystallised. On treatment with nitric acid a brilliant red substance is formed which has the empirical formula of a simple dinitroderivative of the base. Echitamine appears to have an indole nucleus, since it and all its derivatives referred to above give a blue colouration with Hopkin and Cole's glyoxylic reagent for tryptophan, and on distillation with alkalis, echitamine furnishes, in addition to methyl alcohol and methylamine, a substance having the characters of a simple indole derivative.

SOCIETY OF GLASS TECHNOLOGY.

The May meeting of the Society of Glass Technology was held in London and was devoted to a Symposium on the Constitution of Glass. Two sessions were held, at both of which members of the Faraday Society, the Optical Society, and the Physical Society, and others interested in the subject, were present. At the first session on May 25, the President, Mr. T. C. Moorshead, was in the chair; at the second, on May 26, the chair was occupied by Professor F. G. Donnan, F.R.S., President of the Faraday Society.

The following papers were presented:—

The Nature and Constitution of Glass, by Professor W. E. S. TURNER, D.Sc.

The abnormal properties recently observed in glass when heated in the annealing range (properties including greatly increased thermal expansion, heat absorption, and modification of specific electrical conductivity; and the changes of density and refractive index on heat treating glass) had their counterpart in the charges of plasticity which glass exhibited when remelted, or when the raw materials had considerable quantities of moisture or of certain salts present. Two fundamental factors must necessarily be involved in any explanation of these phenomena, namely, molecular complexity and the presence of compounds in glasses. The author proceeded to discuss our knowledge of these two factors in glasses and to suggest explanations for the behaviour of glasses.

On Glasses as Supercooled Liquids, by Professor G. TAMMANN.

In the absence of the author a translation of this paper by Mr. J. H. Davidson, M.Sc., F.I.C., was presented by Mr. F. F. S. Bryson, M.A., B.Sc. A discussion of the influence of degree of undercooling, nucleus number, viscosity and other factors on the production of the glassy state. The customary soda-lime-silica glasses might be regarded as ternary mixtures of Na_2, SiO_3, $Ca\,Si\,O_3$ and $Si\,O_2$. The two components $Na_2\,Si\,O_3$ and $Ca\,Si\,O_3$ crystallised readily, as did practically all metasilicates, and this also applied to their mixtures, from which mixed crystals separated. With an excess of silica, the nucleus number of these mixed crystals was reduced extraordinarily, so that mixtures with an excess of 8 per cent. of silica, or over, solidified as glasses.

On the Constitution and Density of Glass, by DR. A. Q. TOOL, AND E .E. HILL.

This paper was presented for the authors by Mr. E. A. Coad-Pryor, B.A. The condition of a glass was one which was intermediate between the liquid and solid states. Its condition at ordinary temperatures might be considered as undercooled not alone with regard to the process of crystallisation, usually known as the true solidification, but also with respect to the completion of many processes normal to the vitreous condition. Experimental data on the variation of density and of refractive index of a glass through heat treatment were quoted. The maximum density change observed was 1.10.

calc-Calcium Metasilicate-Silica, by DR. G. W. MOREY, AND DR. N. L. BOWEN.

This paper was presented for the authors by Dr. M. W. Travers, F.R.S. The following new compounds were found and their properties determined:— the compound $2\,Na_2O$, CaO, $3\,Si\,O_2$, which melts incongruently, forming a liquid richer in $Na_2\,SiO_3$ and $Na_2\,O$, $2\,CaO$, $3\,SiO_2$; the compound Na_2O, $2\,CaO$, $3\,SiO_2$, which has a congruent melting point at 1248°; and the compound Na_2O, $3\,CaO$, $6\,Si\,O_2$, which melts incongruently at 1015°, forming a mixture of wollastonite and a glass containing approximately 15 per cent. CaO, 67 per cent. SiO_2. The melting point surfaces of the various unary, binary, and ternary compounds existing as solid phases had been determined, and the results were given in tables and curves. The relation of the facts discovered to speculations on the constitution of glass was discussed.

X-Ray Diffraction Measurements on Some Soda-Lime-Silica Glasses (A Preliminary Note), by DR. R. W. G. WYCYOFF AND DR. G. W. MOREY.

This paper was presented for the authors by Miss V. Dimbleby, B.Sc. In some instances the broad bands thought to be characteristic of glasses had been found. In other, however, narrow bands or lines had been obtained, which were as sharp as the lines produced by crystals of colloidal dimensions. Sometimes only one such broad line was observed, in other cases the pattern consisted of several such lines. In still other instances the photograph from a single glass was a composite of lines and broad bands. The positions of the lines were sometimes different from glass to glass, though frequently several glasses agreed in having lines in the same positions. An extended discussion of the results was deferred until many more glasses had been examined.

The Structure of Quartz, by SIR WILLIAM H. BRAGG, F.R.S.

The author observed that the problem of the structure of quartz was one of the first to be attempted some twelve years ago, when the X-rays became applicable to the examination of crystals, and a partial solution was obtained. The data, however, did not completely fix the position of the separate atoms of silicon and oxygen. Four parameters still remained to be determined. One of these referred to the position of the silicon atom, the other three to the positions of the oxygen. The object of the present paper fas to describe a new plan based on the fact that quartz changed its structure on passing through 575° The hightemperature quartz was more symmetrical than the low. A number of considerations showed, however, that the change was not severe, and that if the high-temperature structure could be found, the low-temperature form was not very different. The four unknown quantities reduced to one on passing to the high-temperature form; the silicon atoms are fixed. and the oxygen atoms must lie on certain straight lines. Attempts to fix the positions of the oxygen atoms could be made, based on intensity measurements. The most probable value showed somewhat unexpectedly that each silicon atom was at the centre of a regular tetrahedron, of which the four corners were occupied by oxygen atoms. If it was assumed that the low-temperature quartz was not very different from the high-temperature quartz as determined in this way, the various twinnings of quartz were readily accounted for.

The Viscosity of Glass, by VAUGHAN H. STOTT, M.Sc.

The results of a critical study of the measurements of Dr. G. Washburn and G. Shelton, and of S. English, had been recently published by H. Le Chatelier. In the present paper these measurements were reconsiderd in conjunction with some additional determinations which had been carried out at the National Physical Laboratory. If it was desired to obtain final relations between viscosity and composition, in which errors due to impurities or inaccurate compositions generally, were not considerably greater than the errors of the viscosity determinations themselves, it would be necessary to prepare the glasses from materials of known purity and melt them without contamination. This procedure, which at present precluded the melting of large pieces of glass, would limit the design of viscosimeters.

NOTICES OF BOOKS.

Apologia Alchymiae, by R. W. COUNCELL. (A Re-statement of Alchemy.) 88pp. London: John M. Watkins, 21 Cecil Court, Charing Cross Road.

This is an unconventional Book if ever one was written. Not only is the theory of the alchemists extolled until it apparently becomes an edifice of demonstrated truth, which none dare deny, but there is many a sly dig at, as well as open rebuke of, the great works of both ancient and modern scientists. The author, and also the writer of the foreword, are clearly enthusiasts in a heterodox cause but their enthusiasm does not equal in intensity that of a writer who, not many years ago, wrote a treatise in which he demonstrated to his own satisfaction that the earth was as flat as the proverbial pancake. So mote it be.

Base Exchange in Soils. Being a series of papers and general discussion held by the Faraday Society, December, 1924. Price 5s. Limp Cloth. Faraday Society, 90, Great Russell Street, London, W.C.1.

These papers and the discussion, constitute a useful book by a number of authors on an interesting subject. The first paper is by Dr. D. J. Hissing (Groningen, Holland). He says a part of the bases (lime, magnesia, soda, potash and ammonia) which are or may be present in the soil, is displaced on treating the soil with a solution of neutral salt. Way describes this process as early as 1850 in his famous paper. "On the Power of Soils to absorp Manure." His investigations led him to conclude (1) That the salt was not absorbed as a whole, but only the base; (2) That the filtered liquid contained the acid of the given salt united to lime; (3) That the quantity of lime acquired by the solution corresponded exactly that that of the base removed from it—the action was therefore a true chemical decomposition: (4) That the combination between the soil and the base was rapid, if not instantaneous, partaking, therefore, of the nature of the ordinary union between an acid and an alkali. The process of exchange may be shewn as follows:

$$\underset{\text{Solid Phase}}{\text{Soil}\left\{\begin{matrix}\text{Ca}\\ \text{Mg}\\ \text{K}\\ \text{Na}\end{matrix}\right.} + \underset{\text{Liquid Phase}}{\text{NaCl}} \rightleftharpoons \underset{\text{Solid Phase}}{\text{Soil}\left\{\begin{matrix}\text{Ca}\\ \text{Mg}\\ \text{K}\\ \text{Na}\end{matrix}\right.} + \underset{\text{Liquid Phase}}{\left.\begin{matrix}\text{Ca}\\ \text{Mg}\\ \text{K}\\ \text{Na}\end{matrix}\right\}\text{Cl}}$$

Dr. Missink deals fairly exhaustively with the subject.

The papers are by N. M. Comber, D.Sc., A.R.C.S., F.I.C., "The Rôle of the Electronegative Ions in the Reactions between Soils and Electrolytes; H. J. Page and W. Williams, " Studies on Phase Exchange in Rothamstead Soils "; G. W. Robinson, M.A., and Rice Williams, M.Sc., " Base Exchange in Relation to the Problem of Soil Acidity."; S. F. Saint, B.Sc., A.I.C., on " The Relation between the pH Value, the Lime Requirement and the Thiocyanate Colour of Soils; E. A. Fisher, M.A., B.Sc. F.I.C., F.Inst P., " On Base Exchange in Relation to the Swelling of Soil Colloids "; and then is given a general discussion.

The Physical Chemistry of Igneous Rock Formation. Being a number of papers and a general discussion before the Faraday Society in October, 1924. Limp Cloth. 6s. 6d.

Modern Inorganic Chemistry. By Dr. Mellor. New Edition, 1123 pp. Price 12s. 6d. net. Longmans, Green and Company, 39, Paternoster Row, London, E.C.

The present new and enlarged edition of the above standard work is very welcome, especially as the author has re-written several chapters. A not unimportant matter is the fact that the price remains the same as for the smaller book, 930 pp., as compared with the present edition of 1123 pages.

New Patents.

This list is specially compiled for *The Chemical News* by Rayner and Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuituously.

Latest Patent Applications.

16917.—Ashcroft, E. A.—Treatment of sulphide ores, etv. July 1st.

16,955.—British Cyanides Co., Ltd.—Manufacture of articles from synthetic resins. July 1st .

17,251.—British Dyestuffs Corporation, Ltd.—Manufacture of diarylguanidines. July 4th.

16,914.—Dreyfus, H.—Manufacture of cellulose derivatives. July 1st.

Specifications Published this Week.

213,285.—Chemische Fabrik Von Heyden Akt-Ges.—Process of the manufacture of soluble antimony compounds.

213,599.—Meyerhofer, A. F.—Process of producing inorganic and organic acids.

235,698.—Menke, J. B.—Production of nitrated organic compounds.

225,549.—Jung, P.—Apparatus for ascertaining the composition of gaseous mixtures.

Abstract Published This Week.

233,874.—Cellulose-derivative compositions. —Lindsay, W. G., 11, Astor Street, Newark, New Jersey, U.S.A.

Non inflammable compositions are obtained by incorporating in a cellulose ester, other, or other derivative an aromatic phosphoric ester ,and one or more of the following substances, *viz.*, aluminium phosphate, hydrated aluminium fluoride, calcium phosphate, calcium tartrate, calcium citrate, and magnesium dihydrogen ortho-antimonate. The usual volatile solvents ,such as alcohols, ether, acetone, or amyl acetate, may be used in the process.

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CRITICAL STUDIES ON METHODS OF ANALYSIS. XVI.—ZINC.

By LEON A. CONGDON, A. B. GUSS, AND F. A. WINTER.

(Contribution from the Department of Chemistry, Syracuse University.)

INTRODUCTION.

While zinc as a distinct metal was not known to the ancients, it was known to them as a peculiar kind of copper, which we now call brass. Alchemists knew that copper became yellow when heated with certain ores now known to contain zinc. Some authors claim that the Chinese isolated zinc in the sixth century, others claim that Paracelsus discovered the element zinc about 1520, and still others claim Basil Valentine isolated zinc in the first alchemical period of chemistry. The usefulness of zinc as a distinct metal, however ,did not become prominent until about the eighteenth century.

Commercially, zinc, as zinc oxide, is of immense importance in the manufacture of paint, pharmaceuticals, rubber, celluloid, oilcloth, printing ink, glue, glass, and glazes. Metallic zinc is used in the manufacture of rolled zinc, galvanizing, brass, etc., the utilization of which is found for roofing, battery cells, machines, castings, bronzes, etc.

With the above in view, the analysis, therefore, of zinc is important, and its exact estimation has received a large amount of attention in both scientific and trade journals.

The principle common chemical reactions which are made use of for the purpose of separating zinc from other elements are those with H_2S and $(NH_4)_2S$; with KOH and NaOH; with K_2CO_3 and Na_2CO_3; and with $(NH_4)_2CO_3$. A characteristic qualitative reaction for zinc salts is the treatment with cobalt nitrate heated on charcoal before the blowpipe gives a green mass on cooling, this being known as the Rinmann's green test. In the absence of Mn and Cu, the zinc solution may be qualitatively tested by adding 2 or 3 grams of citric acid per 200 cc. solution, making ammoniacal, and adding ferrocyanide which gives a precipitate of zinc. Del Campo (107) states that 0.005 mgs. of zinc in 1 cc. may be detected by the blue coloration produced by the addition of ammonia and resorcinol, which is changed to red by HCl.

A study of the literature in reference to the quantitative estimation of zinc shows a large number of investigations. Over one hundred original references were perused in this study. Gravimetrically, zinc has been estimated as phosphate, as sulfide, as sulfate, as oxide, as carbonate, as zinc mercury thiocyanate, and by electrolysis. Volumetrically, zinc is generally determined indirectly. Methods are found based on neutralisation, oxidation including iodimetry and the permanganate process, and precipitation methods including the NH_4SCN process. Zinc has also been estimated by means of the volumetric KCN complex method. A few studies are noted on the indirect gasometric method, colorimetric method, turbidity method, volatilization method, and qualitative tests.

Some studies have been reported in the literature on comparison of methods but these are chiefly comparisons and studies of the volumetric precipitation processes. In no case have the authors found in the literature a systematic experimental study of all the most important methods pertaining to zinc on a salt of zinc of known purity.

2.—GENERAL CONSIDERATIONS.

A clearer viewpoint can be obtained as to the estimation of zinc by the above-mentioned methods by discussing the general principles of each process that has been proposed.

(a) *As Phosphate (Gravimetrically).* Hugo Tamm (1) in 1871 was the first to suggest the determination of zinc as zinc ammonium phosphate. He found that sodium phosphate precipitates quite completely a neutral or slightly acid solution of zinc chloride and ammonia. In this study he prepared zinc ammonium phosphate, showed the behaviour and composition of this salt and its value in the estimation of zinc, and also the estimation of zinc by this method in spelters and its compound, in blends, and in brass, etc This method has been studied by various investigators, among whom may be mentioned the following:—In 1882, G. C. Stone (2); in 1886, G. Losekam and Th. Mayer (3), and M. Bragard (4); in 1899, M. Austin (8), A. C. Langmuir (9) and M. Fouget (10); in 1900, H. D. Dakin (11); in 1909, R. W. Langley (12); in 1909, 1911, 1912, and 1913, K. Voit (13); in 1911 and 1912, V. Hassreidter (14); in 1911 and 1912, Frank O. Taylor, et al. (15); in 1913, T. M. Findlay and A. C. Cummings (16); in 1921, G. Luff (17) and L. W. Winkler (18).

The original method of Tamm (1) has been studied chiefly from two view-points, namely, the slight decomposition of the $ZnNH_4PO_4$ precipitate with wash water as a result of hydrolysis, and secondly, the effect of sodium and ammonium phosphate as precipitants in the formation of the $ZnNH_4PO_4$. To this may be added comparative results as to weighing the precipitate as $ZnNH_4PO_4$ or igniting and weighing the substance as $Zn_2P_2O_7$.

Langley (12) in working on the problem of zinc as a phosphate shows that $(NH_4)_2HPO_4$ is more suitable than Na_2HPO_4 as a precipitant, while water is as effective as a solution of $(NH_4)_2HPO_4$ and alcohol in washing the precipitated $ZnNH_4PO_4$. He also finds there is no interference by excess of ammonium salts.

Taylor (15) acting as Chairman of the Committee on Standard Methods of Analysis, American Chemical Society, in June, 1911, reported the $ZnNH_4PO_4$ method to be the most reliable and efficient method for the estimation of zinc that could be found at that time Winkler (18) in 1921, likewise recommends zinc to be estimated as $ZnNH_4PO_4$, drying at 130°.

(b) *As Sulfide (Gravimetrically).* Many chemists have been reluctant to determine zinc as the sulfide gravimetrically because of the difficulty and time consumed in filtering the precipitate and also some difficulty in heating the ZnS in such form of definite composition. Anthony Guyard (19), in 1882 was successful in estimating zinc as the sulfide, when he found that crude ammonium sulfo-carbonate precipitates zinc insoluble in excess at 66°-80°. The precipitate thus formed is dried at 100°-110°, at which temperature it is converted to ZnS and may be weighed as such. Guyard claimed this method to separate zinc from alkalies, lime, Mg, Mn, Cu, Ni, and Co. W. F. Lowe (20), in 1892 worked out a method of separating zinc from Mn in ores as a sulfide.

A. Thiel (21) in 1904 boiled a zinc solution with ammonium acetate plus H_2S. The zinc sulfide thus formed is filtered, heated to 120° in a current of H_2S and then in a current of hydrogen to get rid of the last traces of sulfur, the zinc then being weighed as sulfide.

G. Weiss (21a) in 1906 investigated the precipitation of zinc as sulfide in H_2SO_4 solution by H_2S and found that the completeness of the reaction was due to the rate of running in the H_2S and the temperature of the solution. A fast rate of bubbling in the H_2S and room temperatures were the optimum conditions.

P. Pipereaut and A. Vila (22) in 1907 add pure sulfur to a boiling solution of zinc in caustic soda or potash which causes a precipitate of white ZnS in dense form.

In 1912, N. Schilling (23) freed a solution containing Al, Fe, Mn, etc., by NH_4OH and H_2O_2 from these elements, the filtrate containing the zinc. The zinc was determined in the filtrate by adding an excess of KOH and then benzene monosulfonic acid and H_2S, the zinc precipitating as the sulfide.

K. Bernemann (24) in 1913 added sodium hydrogen sulfite to a chloracetic solution of zinc through which was passed H_2S. This is a mutual precipitation process, the particular colloid to assist the precipitation of the ZnS is sulfur. Some useful information is given by this paper on the ignition of ZnS precipitates.

In 1919, Harold Fales and Gertrude Ware (25) studied some of the conditions for the precise determination of zinc as the sulfide, especially from solutions in formic acid by means of H_2S. The found that the most favourable range of hydrogen ion concentration for quantitative precipitation of ZnS in a form suitable for rapid filtering and washing is 0.01 to 0.002. The concentration

may be kept at this range by means of "buffers," *i.e.*, mixtures of formic acid, ammonium citrate, ammonium sulfate, ammonium acetate, and potassium acid carbonate. They also found that granules of ZnS is favoured in the precipitate not only by a high concentration of amonium salts of a strong acid, by a volume of 100 cc. for each 0.1 gram of zinc present, and by a temperature of 95° to 100°. Passing H_2S under pressure is desirable, both for rapid saturation, and to avoid loss of formic acid by evaporation In addition to weighing zinc as the sulfide, they found it could be converted to the sulfate by treatment with H_2SO_4 and weighed as sulfate.

(c) *As Sulfate (Gravimetrically).* The estimation of zinc by weighing as the sulfate has received some attention. In this method, the zinc is separated as the sulfide and then converted to the sulfate by heating with sulfuric acid E. C. Sullivan and W. C. Taylor (26) determine zinc as the sulfide in acid solution, then redissolve the ZnS precipitate with HCl and evaporate with H_2SO_4 to dryness. F. Seeligmann (27) adds NH_4OH to the solution of zinc, then $(NH_4)_2S$ and boils until the precipitate coagulates. The ZnS is then filtered, ignited, and finally heated with H_2SO_4 to a dull redness and the zinc weighed as $ZnSO_4$. Methods given in the Proc. Amer. Soc. Testing materials (28) for the tentative methods for the chemical analysis of gun metal, recommend zinc by weighing as $ZnSO_4$. A. Gutbier and K. Starb (29) estimate zinc by weighing as sulfate and declare the method to be accurate. They find, however, that if $ZnSO_4$ is heated strongly over a Teclu burner, the $ZnSO_4$ is transformed quantitatively to ZnO, and say that this fact may be used as a basis for checking the results obtained by weighing as $ZnSO_4$.

(d) *As Oxide (Gravimetrically).* Euler's (30) work on the quantitative transformation of $ZnSO_4$ to ZnO by the strong heat of the Teclu burner has been confirmed by the work of Gutbier and Starb (29).

G. Spacu (31) estimates zinc as the oxide, after precipitating a neutral solution of a zinc salt with NH_4SCN and a few drops of pyridine. The reagent is added slowly with vigorous stirring and the white precipitate of $ZnPy_2(SCN)_2$, after 15 minutes, is washed with a cold solution of 0.3 gram of NH_4SCN, 0.2 gram of $(NH_4)_2SO_4$, and 100 cc. of water. This precipitate is then dried, and ignited over a Teclu burner, and weighed as ZnO. The method is said to separate Zn from Mg and the alkaline earths.

Lundell and Scherrer (32) give some notes on the analysis of cast bronze from work done at the U.S. Bureau of Standards and by co-operating chemists. The zinc is determined as oxide, after separation as sulfide, by strong ignition.

(e) *As Carbonate (Gravimetrically.)* Grossman and Schuck (33) find that zinc gives a precipitate with guanidine carbonate, which is insoluble even on warming. The advantages of the precipitant are the ease with which the precipitant may be filtered and the lessened importance of removing the last trace of the precipitant, since guanidine carbonate can be volatilised.

(f) *As Mercury Thiocyanate (Gravimetrically).* Lundell and Bee (34) employ KSCN, $HgCl_2$ mixture as a precipitant, followed by filtration and weighing on a Gooch crucible. Jamieson (35) shows that a NH_4SCN, $HgSCl_2$ mixture is equally satisfactory.

(g) *By Electrolysis.* J. M. Merrich (36) in 1871 estimated zinc by a feeble galvanic current. M. A. Riche (37) determined Zn in 1877 by exposing the solution of the substance dissolved in H_2SO_4 or HNO_3 saturated with ammonia and an excess of methyl alcohol to the action of two elements giving a deposit of zinc on a cylinder of platinum as negative pole. In 1881, H. Reinhardt and R. Ihle (38) formulated a new method for the electrolytic estimation of zinc by taking neutral solution of $ZnCl_2$ or $ZnSO_4$ and an excess of neutral K_2CrO_4 added until the precipitate of $ZnCrO_4$ is redessolved, then this solution is subjected to electrolysis with deposition of zinc. G. Vortmann (39) used a double oxalate solution of zinc for its separation by electrolysis in 1891 H. H. Nicholson and S .Avery (40) in their study of the electrolytic estimation of Zn, take a solution of $ZnSO_4$, add 3 cc. of acetic acid, partially neutralize with 1 gram of Na_2CO_3, dilute to 150 cc. and finally electrolyse with a current of 0.02 ampere for 3 hours.

Nissenson (41) compared the electrolytic estimation of zinc as a sulfide and its titration both with ferrocyanide and sodium sulfide and found that he obtained equally good results.

Lilly G. Kollock and Edgar F. Smith (42) estimate zinc electrolytically with the aid of the mercury cathode and rotating anode. Thirty-nine experiments with 0.1316 gram

of zinc as sulfate showed the method to be reliable using the following conditions:- Volume of solution 10 cc., current 1/3 ampere, 3.5 to 5 volts, rotation of anode at 550 to 750 r.p.m., time was 12 to 15 minutes, cathode surface 20 sq. cm. Any losses were attributed to poor manipulation only.

W. Neumann (43) describes an electrolytic method for zinc whereby 0.008 mgs. of zinc in 0.1 cc. of solution may be detected.

Spear, Wells, and Dyer (43) have studied the electrolytic determination of zinc. They find that the sodium acetate, K_2CrO_4, and KOH methods all yield high results (from 0.2% to 4%). Results are recorded of numerous determinations carried out under arying cvonditions. For the detection of small quantities of Zn, particulars are given for the $K_4Fe(CN)_6$ test which they state is more certain than $(NH_4)_2S$ or H_2S.

L. C. Wilson (45) mawe a study of determining the weight of deposit in the electrolysis of zinc. This deals with the volumetric $K_4Fe(CN)_6$ and the electrolytic methods for determining zinc, removal of Zn coatings by NaOH and the Preese ($CuSO_4$) test.

A. Lassieur and Mme. A. Lassieur (46) devise a rapid electro-analysis of brass. The brass is dissolved and after adding other materials to prevent deposition of iron, the solution is electrolysed, using a copper cathode. After electrolysis is complete, the cathode is removed, and the zinc dried and weighed.

K. Brusch and K. Chaluyny (47) have studied the estimation of small quantities of zinc in commercial nickel. In the presence of considerable nickel, it was found impossible to precipitate pure ZnS in solutions containing formic acid and ammonium formate under conditions most favourable for the separation of zinc and nickel. Similarly, attempts to deposit zinc on a cathode from cyanide solutions were unsuccessful, since a little nickel invariably deposited on the cathode with the zinc. The most satisfactory separation of all the methods tried was to precipitate the zinc as ZnS from the solution of complex cyanides by means of Na_2S, dissolve the precipitates with H_2SO_4, boil off the H_2S, and neutralise. The zinc was then deposited electrolytically on a copper plated gauze revolving 200 r.p.m. In this study methods for washing the zinc deposit are given.

(h) *By Potassium Ferrocyanide (Volumetrically).* In this volumetric precipitation method the zinc must be separated from interfering metals which might form insoluble ferrocyanides. If zinc is in the form of ZnS, it is re-dissolved in HCl and titrated with a standard solution of $K_4Fe(CN)_6$, the following reaction taking place first:—

$$(1)\ 2\,ZnCl_2 + K_4Fe(CN)_6 = 4\,KCl + Zn_2Fe(CN)_6.$$

The zinc ferrocyanide, so formed, does not flocculate readily but as more ferrocyanide is added to the hot solution, a potassium zinc ferro-cyanide is precipitated:—

$$(2)\ 3\,Zn_2Fe(CN)_6 + K_4Fe(CN)_6 = 2\,K_2Zn_3(Fe(CN)_6)_2$$

combining equations (1) and (2) we have:—

$$(3)\ 3ZnCl_2 + 2K_4Fe(CN)_6 = 6\,KCl + K_2Zn_3(Fe(CN)_6)_2.$$

As indicator for the above reaction, a solution of uranium nitrate, acetate, or uranyl chloride has been used. Other indicators which have been suggested are tungsten nitrate or acetate and also ammonium molybdate. As auxillary to these indicators a solution of $FeCl_3$ has been proposed. These indicators are used outside the solution on a test plate. When uranium salts are used, a brown ferrocyanide of uranium is formed. The yellow or brown colour that is produced by a slight excess of ferrocyanide with ammonium molybdate is of unknown composition. This process was originally devised by M. Galletti (48) in 1864. It was later modified by A. H. Low (49) in 1893 and 1900. This volumetric process for zinc is sometimes referred to as the "American Process." The ferrocyanide process for zinc has received considerable study by a large number of investigators, most of whom find that the method is easily performed and is fairly accurate if the details of the standardization are watched closely. Furthermore, most of the errors in the estimation of zinc by this method have been traced to methods used in separating zinc from interfering metals that effect the process. As to efficiency of the process, it has been found that various indicators used have all given good results in different hands, and men who are entirely successful with one indicator often have great difficulty in obtaining good results with some of the other indicators. This naturally has led to the use of different indicators and nearly half of the published modifications of the Galletti process have tried to make the end of the reaction more distinct by trying and suggesting new forms of indicators, or an auxillary indicator.

(To be continued.)

THE BUSINESS VALUE OF CHEMISTRY IN EDUCATION.

By John Malpas.

A careful study of the relations of chemistry to industrial practice should create in the mind of the student a system of attack for learning his chosen occupation in life, enabling him to grasp more quickly the numerous facts that other sources bring to him and to put them systematically together, as managing directors have to do.

There can be no doubt that the commercial side of chemistry is much more prominent than the chemical side. To-day far more attention is being drawn to its value in the public Press and as shown by the increased number of books relating to the subject—books both for the uninitiated and for the more advanced workers in the field.

In modern life the applications of chemistry are countless. In many cases the laboratory is the brains of the factory. Hence, chemical discoveries have a decided monetary value. Many a discovery which, at the time was of scientific interest only, afterwards is proved to have a marked commercial asset. This can be exemplified on every side, although it is possible only to cite a few instances now. The coal-tar industry holds a unique position, for it owes its origin entirely to scientific investigations. Much valuable work has been done in the matter of combustion, petroleum and gaseous fuels. Then, again, in the manufacture of incandescent lights and the prevention of oxidation of the metallic filament in the bulb ,which is another illustration that is taught by a so-called theoretical science. No practical-minded man neglects such opportunities afforded him when convinced that useful applications may follow.

Two remarkable cases may be cited to show where a synthetic discovery has changed completely the character of an industry. They are the two valuable dyes—alizarin and indigo.

The chemist has been, and is still, an important factor in the war on waste, and some of his wonderful achievements have been circulated far and wide. Many of the "once upon a time" unprofitable industries are now financially stable because the obnoxious by-products which were thrown aside, causing a nuisance to all, have become a source of revenue to the industry It has been said often that the fortunes of an industry depend on the extent to which its waste products can be utilised successfully. And also it is clearly evident that any success in this direction depends upon the application of scientific method.

It must, of course, be borne in mind that technical processes have been made possible only by the co-operation of the chemist with the engineer, for the obvious reason that a chemical change which proceeds quite smoothly in a chemical laboratory, offers many difficulties when the attempt is made on a manufacturing scale, where a further knowledge than that possessed by the chemist is required. Both of them are essential for the successful solution of the many problems which arise in connection with manufacturing chemistry.

This is not, however, the only side of chemistry which is valuable. Also it is an excellent field in which to lay the foundations for mental development—a side that is often lost sight of where chemistry is concerned. It teaches a boy just those things without which no one can ever succeed—application, observance of details, method, regularity and accuracy. The definite procedure taught enables the student to apply the same process when acquiring knowledge of other subjects in the most economical and efficient way. The observance of details is the best way for further developing general truths and concepts.

The training depends to a large extent upon the type of teacher as well as upon the total environment and sociological conditions which supply the raw material of thought. Business has to adopt the general principles of "Trial and Error," whether applied in the office or workshop. These experiments can, however, only be of service when they have been carried out in an orderly manner, proceeding step by step. A course of practical chemistry instills these principles early in the mind of a boy. The untidy bench quickly reveals the state of the mind for success in business, and for that matter, in most walks of life, but if taken early in hand, much improvement can be made. Hence, apart from what is learned in chemistry, the study also affords an excellent training ground for future work in the business world.

In business life, observation is the golden key, but it means something much more than merely seeing. It is an intelligent understanding of men as well as things. The importance of accurate observation cannot be over emphasised, as is only too well known to all of us when reading the various police court cases in which two witnesses flatly contradict one another. In

after-life a keenly observant boy soon discovers the reason why, in any main street of his city, that one side is far more crowded with people than the other, and also the reason for the brisker trade.

Success, undoubtedly, is not going to depend on secret processes alone, but also on good organisation. It is a striking fact that two firms employing the same machinery and working by the same methods, produce quite different results. One of the factories is far more successful. What is the discrepancy? Supervision! In the successful firm every detail of the operations is noted down at each stage so that possible losses may be remedied. Laboratory experiments of the process often discover these losses and what is approximately their extent.

Everyone cannot gain honours by making new discoveries, although each one who is in any way connected with the many operations of production can have a high standard at which to aim, whereby in the interests of material conservation any needless waste can be avoided.

One would like to add a great deal more with regard to the accomplishments of chemical research, and all that it has done for the safety of human life and its countless services to man. But I think sufficient has been said to show its value as a commercial education.

In conclusion, I quote some striking words which appeared in the North American Review of March, 1896. The message was prophetic and is well born out by subsequent events. It showed far-sighted vision when the author said:

" It is fair to hold that the country which has the best chemists will in the long run be the most prosperous and the most powerful. It will have at the lowest cost the best food, the best manufactured materials, the fewest wastes and unutilised forms of matter, the best guns, the strongest explosives and the most resistant armour. Its inhabitants will make the most of their country's resources; they will be the most healthy and the most free from disease; they will oppose the least resistance to favourable evolution; they will be the most thrifty and the least dependant on other nations. The education of its people in chemistry and the physical sciences is the most paying investment that a country can make. Competition to-day between nations is essentially a competition in the science and applications of chemistry."

THE RETIREMENT OF DR. CHARLES F. JURITZ, M.A., D.Sc., F.I.C., ETC.

(Late Chief of the Division of Chemistry, Union of South Africa.)

The Press of South Africa has very generally commented favourably on the notable service which Dr. Juritz has conferred on the Union of South Africa, and to science generally. Dr. Juritz has, it will be remembered, contributed several important articles to *The Chemical News*. After an extended and favourable notice on the career of Dr. Juritz, the Journal of the Department of Agriculture, Pretoria, says:

DR. C. F. JURITZ, M.A., D.Sc., F.I.C., etc.

" Dr. Juritz has at various times held office as President of the Cape Chemical Society, the South African Association of Analytical Chemists, and the South African Association for the Advancement of Science. He is a member of the Council of the Royal Society of South Africa and of the General Committee of the ritish Association for the Advancement of Science. In 1906 he was elected a Fellow of the Institute of Chemistry of Great Britain and Ireland. In 1907, after completion of his ' Study of the Soils of Cape Colony,' the University of the Cape of Good Hope conferred on him the

degree of Doctor of Science, and the same degree was conferred on him in 1914 by the University of Adelaide, South Australia. In 1922 he was elected a Fellow of the Royal Society of Edinburgh .

South Africa has produced many notable men, and Dr. Juritz takes an honoured place among those scientists who have wrought much for their country. And he occupies a special niche, for a great deal of his research and investigation was of an original, and, so to say, pioneering nature, embracing many matters of importance to the opening country, as evidenced in the numerous writings and reports that stand to his credit to-day. In the Department which he has so long and honourably served, he leaves on his retirement a sense of pride at the achievements of a fellow-worker, who has done much in raising the status of the Department of Agriculture to the high level it now enjoys.

General Notes.

INCREASED PRODUCTION IN CANADA IN 1924 OF ARTICLES MANUFACTURED FROM NON-FERROUS METALS.

The High Commissioner for Canada in London has received from the Dominion Bureau of Statistics at Ottawa, a bulletin from which it appears than in 1924 there were 340 concerns (representing a total capital investment of $116,526,157) engaged in manufacturing non-ferrous metal products in Canada. Raw materials costing $44,457,475 were converted into manufactured articles with a total selling value of $95,754,162; this was the largest output since 1920, and a substantial increase of 7.5 million dollars over that of 1923. Net wealth added by the manufacturing processes was $51,296,687, as compared with $45,424,062 in the previous year. During the year this group of industries afforded employment to 21.816 persons and paid $26,134,914 in wages and salaries.

Increased production was reported in all but the brass and copper products industry and in the miscellaneous non-ferrous metals group; the former showed a decrease in the value of output and the latter maintained production at the level of the preceding year. The aluminium industry showed a slight improvement over 1923, and the lead, tin and zinc products industry recovered from a poor year and produced commodities with a selling value of 3.2 million dollars, an increase of a million dolars over the previous year. Concerns manufacturing electrical apparatus and supplies showed continued expansion with a production worth 151 million dollars; the highest point yet attained; precious metal products industries also showed increased activity and had an output valued at two million dollars in excess of that in 1923.

Imports to Canada for the non-ferrous metal trade declined from $43,432,617 in 1923 to $41,660,085 for 1924; of this total, $34,081,128, or 81.8 per cent., came from the United States, and only $4,029,750, or less than ten per cent. from Great Britain. Exports during the same years rose from $65,911,171 to $84,780,015. Exports to United States in 1924 was $55,128,028, or 65 per cent. of the total, and $14,992,464, or 17.7 per cent. went to Great Britain.

THE DYE-STUFF PRODUCTION ENCOURAGEMENT LAW IN JAPAN.

It is said that Imperial and departmental ordinances regarding the application of the Dye-Stuff Production Encouragement Law, which passed the last session of the Imperial Diet, have been drafted and will be promulgated in August at the latest. The dyes to be subsidised have been almost decided to be rhodamine, mazenda, wool green, S. hudron blue and indunthlene blue. The kinds will be increased gradually.

The subsidy will be given at the rate of 6-8 per cent. interest on the production of the above kinds, according to the cost of production and the market price. For this fiscal year, about 800,000 yen will be appropriated for the grant. The law will be put in operation on and after October 1st.

CONSUMPTION OF DYE STUFFS DURING 1924.

The Industrial Bureau of the Department of Commerce and Industry give the total consumption of dye stuffs, imported and produced in Japan, during 1924, at 7,179 tons, valued at 34,172,000 yen. This amount includes the imported and domestic-made goods nearly in equal proportions in value and in proportion of 27 per cent. of the imported goods and 73 per cent. of the domestic-made goods, in quantity there being a yearly increase in the consumption of both goods and a consequent increment in their importation and production.

DIRECTOR OF FOREST PRODUCTS RESEARCH.

The Secretary of the Department of Scientific and Industrial Research reports that the Lord President of the Council has appointed Mr. R. S. Pearson, C.I.E., F.L.S., Forest Economist, Forest Research Institute, Dehra Dun, India, to be Director of Forest Products Research under the Department of Scientific and Industrial Research.

Mr. Pearson will be in charge of the Forest Products Research Laboratories, in which pure and applied scientific research will be carried on to meet the practical needs of the using industries and of Departments of State.

U.S.A. CHEMISTS' VISIT.

Eighty American chemical engineers have arrived in England to attend the Convention of the Society of Chemical Industries at Leeds. Arrangements have been made by the London Midland and Scottish Railway for the party to make a tour, after the Convention, of English and Scottish beauty spots, including the Trossachs ,the Lake District, and the Shakespeare country.

GYPSUM.

(Dominion (Canada) Bureau of Statistics.)

Finally revised statistics on gypsum production as reported by the Dominion Bureau of Statistics at Ottawa, under the authority of the Hon. Thomas A. Low, show that the quantity of Canadian gypsum sold during 1924 was appreciably higher than in the previous twelve months. The total production for the year was 646,016 tons with a valuation of $2,208,108, as compared with 578,301 tons at $2,243,100 in 1923. The production was made up of lump, crushed, fine ground and calcined gypsum sold; there was also included the calcined gypsum used in the calcining plants for the production of wall plaster, wall board, alabastine and other gypsum products.

The average values received by operators were as follows:—Lump, $1.81; crushed, $1.82; fine ground, $5.82; and calcined, $10.27 per ton.

Compared with 1923, the imports remained constant while the exports ,principally crude gypsum, increased approximately 75,000 tons to a total of 477,462 tons.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURE.

The ninth annual general meeting of the Association of British Chemical Manufacturers was held at the Chemical Society's Rooms, Burlington House, Piccadilly, W., on Thursday, 9th July, 1925.

Report and Accounts.

The Chairman (Mr. D. Milne Watson), in moving the adoption of the report, said: "Chemical industry, like all other British industries—but fortunately not to such a great degree as some other industries—is going through a verious serious time. I attribute this mitigation in respect to chemical industry to the organisation which you have built up during the past nine years. But it is a time when the nerves of all industrialists are very much on edge; it is a time of danger to all engaged in the industry. In every industry there are some who are weaker and some who are stronger than others. The tendency of the weaker brethren is to attempt new developments on their own account and sever their connection with their fellows. I do not think that is a wise policy. The only hope for such firms is to tighten up the bonds they make with our organisation, not to sever them. Paradox is a commonplace of life. Fuller support is given to a trade association in times of prosperity, but a strong association is never so much needed as when trade is bad, as it is at present.

Another point I want to make is that what an association can do for a member, the same individual firm cannot possibly do for itself; and conversely, the association cannot do many things which the firm alone can do. Thus the work of the firms and of the association is complementary. The one is incomplete without the other. May I illustrate my point? I conceive it possible that every one of the members of a particular group may be efficient and economic producers of the chemicals for which they are responsible, and yet the business in that particular branch of the industry may not be good. It may be ruined by indiscreet and uninformed action on the part of the Government, unless there is an association of this kind to prevent such action. It may be set back unless other branches of the industry are prepared to co-operate with it, and such co-operation is only likely if both

branches are members of the same association. The technical efficiency of the group may count for little if such efficiency is not accorded due publicity, and that will not be accorded unl ss there is an assoication to see that it is done.

Looking facts squarely in the face, as I always attempt to do, it seems to me certain that unless any particular firm is absolutely sure of its position, it may become a casualty, so to speak, in the industrial fight, unless it is prepared to act alongside its associates. This was my view when you did me the honour to elect me as your Chairman, and I hold it ten times more strongly after twelve months in that position.

Before I turn to the account of our stewardship, which you will find in the annual report which the Council presents to you to-day for your acceptance, I want to refer to the great loss which one of the branches of the chemical industry has sustained in the death of Lord Leverhulme. Lord Leverhulme's companies are members of our Group III—Soap—and we join with them to-day in mourning the loss of a great man. Simplicity is an attribute of the truly great, and I feel that only simple words can be appropriate in attempting to describe our feelings about Lord Leverhulme. I am told by those who heard it in Liverpool last year, and I can well believe it, having read it, that his Messel Memorial Lecture was a masterpiece; the original contribution of a master-mind. He was a great man in the breadth of his outlook on life, in his power of mental concentration, and in that catholicity of temperament which embraced both art and industry; and, as we all know, he had great originality and driving power.

The membership of your Council has remained unchanged during the year save in one respect. Sir William Alexander resigned his membership on vacating the managing directorship of the British Dyestuffs Corporation. I am sure you will agree with me that we are fortunate in being able to replace him by co-opting Sir Alfred Mond, whom we are particularly glad to welcome back as one of the founders of the Association.

One of the most important events of the year has been the celebration of the discovery of benzene: a very happy incident, inasmuch as it afforded an opportunity for bringing together chemical scientists and industrialists. I am sure we are extremely glad to have been associated with the scientists officially in that centenary, and I believe it was probably the first occasion that the industrialists and the scientists had met together on a common platform in this connection. It was in every way a unique event. The Royal Institution invited the Chemical Society, the Society of Chemical Industry and our Association to assist the Institution in arranging the event. No such invitation has ever been issued before, and this essay in co-operation was so fruitful in its results that I look forward to similar functions in which both scientific and industrial and industrial societies and associations can join.

The British Empire Exhibition has again this year been supported by the Association and whatever may be the financial results to the Guarantors—and for this the Exhibition Authorities must answer—the chemical industry has played its part well. It has been infinitely more difficult to organise the display in the chemical section this year than last, partly because a great many doubted whether the Exhibition would be a success another year, and partly because the enthusiasm that existed last year, has, to a certain extent, waned. The results, however, in point of fact, have been excellent. The exhibits last year were, as they should have been, classical in their presentation of the scope of British chemical science and industry, and as such they were judged. This year, fortunately, the altered position was foreseen, and a different viewpoint was taken. In the result, we have a chemical exhibit which is in many ways a great advance on that of last year. It is informative to the general public. Here, again, I notice the spirit of co-operation has permeated our members. Last year the scientific section was the only example of this. It is repeated this year, but in addition there is a tar exhibit of a very striking character, bearing only the legend " British Tar for British Roads," and that remarkable stand, " The Dyestuffs of Great Britain."

Speaking of propaganda reminds me of the short paragraph in the report with reference to the association's films. Hundreds of thousands of the public must have seen these films and copies are now going to Japan.

I turn now to two items in the report which deal with the two branches of our industry which have been the subject of protective legislation—dyestuffs and fine chemicals.

With regard to dyestuffs, the year, I

sincerely hope, has brought us a little nearer the solution of the problem. Its difficulties are apparent to everyone; some of them are of our own making; others are the result of the aftermath of war. There are, however, two bright spots which have emerged during the year. The first is the closer co-operation which has developed between the dyestuffs industry and other branches of chemical industry. I do not want to overstate the degree to which this has gone. It is perhaps the willingness to co-operate which has appeared, which we should welcome, because of the possibilities it holds out for the future. Then, we are all hoping for great things from the appointment of Dr. Armstrong to the point of Managing Director of the British Dyestuffs Corporation (hear, hear). He goes there with the hearty good wishes of all his friends in the chemical industry, and any assistance we can give him will, I am sure, be rendered with alacrity if he will let us know what he wants.

The task before the British Dyestuffs Industry is a difficult one. I think we sometimes forget that there is no country in the world which is attempting to run a dyestuffs industry of its own which is not finding the task difficult. In America an extra 5 per cent. has been added recently to the tariff, and during the first five months of this year twice the weight of foreign dyes has been imported into America as compared with the same period last year. Even in Germany and in Switzerland, the industry has its difficulties. The same applies to France, whilst in Italy and Japan the obstacles are even greater. I do not mention this by way of offering any excuse for the British industry, but rather to indicate that in my judgment, however great the efforts put forth by the British makers may have been, they will have to be redoubled before the Industry can be said to be safely established on an adequate scale in this country. I trust, therefore, that the spirit of co-operation which has received some small impetus this year will achieve even greater results in the year which is to come.

The fine chemical group of our Association have had, judging from the reports presented to the Council, a fairly quiet year. However, a very strenuous year awaits them. They have not been so much in the public eye as the dyemakers, but it is to the public, as represented by the House of Commons, that they must now appeal. The Safeguarding of Industries Act expires next year, and it seems obvious to me that this or any other Government which may be in power will require to know what progress has been made in the manufacture of fine chemicals and what effect the Act has had. I am, therefore, very glad to know from the Chairman of the Group that in anticipation of any such demand which may be made, the members of the group are already having what I may call a stocktaking of the position. The Council is expecting to receive a full report from the group in the autumn and will then review the whole situation.

Legislation threatened and accomplished during the year has received the careful attention of the Council. We still, fortunately, have a small band—reduced to two members of Council—who are in the House of Commons, and I have heard regret expressed more than once at Council meetings that their number is not larger. Matters affecting the industry are frequently arising in public affairs and it is well that our voice should be heard, so that if anyone has political ambitions, to whatever party he may belong, I am sure from our particular point of view we shall be glad to give him what support we can, and wish him well.

With regard to matters of transport our Traffic Committee has again rendered us most excellent service during the year. The policy of negotiation with the railway companies, which has always found favour with our members, has been continued, and with, I think, satisfactory results.

With that brief sketch of what has been accomplished during the year, I formally move:

'That the report of the Council of the Association be and it is hereby adopted.'"

The motion was seconded by the Vice-Chairman (Mr. R. G. Perry), and after the Honorary Treasurer (Mr. C. A. Hill), had made his statement, a general discussion followed.

The report was then adopted.

CHEMICAL SOCIETY'S LIBRARY.

The Library will be closed for stocktaking from Monday, August 3rd, until Saturday, August 15th, inclusive, and will close each evening at 5 o'clock, from August 17th to September 12th.

MINERALOGICAL SOCIETY.

June 16, Professor W. W. Watts, F.R.S., President, in the chair.

The Use of the Stereocopic Protractor for the Interpretation of Laue Crystal Photographs, by Dr. A. Hutchinson.

By a slight modification the Stereographic Protractor previously designed by the author can be used for the interpretation of Laue photographs.

The Use of Alignment Charts in Crystal Optics, by Dr. A. Hutchinson.

The alignments charts in common use amongst engineers can be applied to the calculation of refractive indices measured on the total refractometer.

The Crystal-Structures of the Sulphides of Mercury, by H. E. Buckley and W. S. Vernon.

The powder method of X-ray analysis showed that the precipitated black sulphide is cubic with the symmetry of the natural metacinnabarite and with an arrangement of atoms like that of zinc blende, a = 5.85A°; d (Hg-S) = 2.54A°. In cinnabar the arrangement of the Hg and S atoms is a rocksalt one slightly compressed along the trigonal axis and with a slight readjustment of atoms parallel to the basal plane, a = 4.16A°, c = 9.54A°, c/a_4 = 2.291. The type of movement in best agreement with the symmetry is D_3. In cubic mercuric sulphide each atom has four oppositely charged neigrbours at a distance of 2.54A° as in the cubic mercuric sulphide, and two others at a distance of 2.91A°. These facts indicate an eccentricity of the mercury atom if the sulphur atoms are regarded as spherical. In cinnabar, in accordance with the circular polarisation ,sulphur atoms run down through the structure in trigonal spirals.

Albite and other Authigenic Minerals in Limestone from Bengal, by Dr. Edmondson Spencer.

The limestones of Cuddapah age near Raipure, Bengal, contain well-formed crystals of pure albite, apparently authigenic in origin. The crystals are tabular on the trachy-pinakoid and are lozenge-shaped. They are twinned on Carlsbad and albite laws similarly to those of the well-known Roc-tourné type, but of different habit. Accompanying the albite are phlogopite, tourmaline, and quartz crystals, all believed to be authigenic. Comparisons are instituted with similar occurrences of felspars in limestones from various European localities.

Chlorophæite in the Dolerites (Tholeiites) of Dalmahoy and Kaimes Hill ,Edinburgh, by Dr. Robert Campbell and J. W. Lunn.

The dolerites of Dalmahoy and Kaimes Hills are exceptionally rich (up to 15% or more) in Chlorophæite, which occurs as a vesicle mineral, as veins, and as pseudomorphs after fayalite. The mineral has a refractive index 1.498, hardness 1.5, and density 1.81, it has no cleavage and is isohropic. It shows on exposure a striking colour change from bright olive-green to black, due to rapid oxidation. From its physical and chemical characters the mineral is regarded as of a colloidal nature.

Tenth List of New Mineral Names, with an Index of Authors. by Dr. L. J. Spencer.

SHEFFIELD CONFERENCE OF THE ROYAL MICROSCOPICAL SOCIETY.

April, 1925.

Test Objects for Metallurgical Microscopy, by F. Rogers, D.Eng., B.A., M.Sc., M.Inst.Mech.E.

Microscopists have for a long time used a number of readily available natural specimens as objects by which the performance of their lenses can be properly tested; probably nothing simpler or more direct can be conceived. Such a test is not so definitely quantitative as those which opticians may require during the manufacture and adjustment of lenses.

Amongst transparent objects a number are well recognised as forming convenient test objects for certain magnifications. These test objects, which are well known, and which need not be particularised here, are generally available, and there is a considerable degree of consistency in the arrangement and scale of the detail in them.

In metallurgical objects the primary property distinguishing them from most other objects is that they are opaque. , A further property is that they are not usually perfectly plane; a slight relief is produced by most of the methods of preparation; and heat tinting, which does not give any relief, usually does not give such sharply defined details as etching.

The Micro-Examination of Refractory Materials, by W. J. Rees, B.Sc.Tech., F.I.C.

There are three general methods which may be used in the micro-examination of refractories. (a) The examination of thin transparent sections by transmitted light; (b) the examination of flat polished surfaces

by reflected light ;(c) the examination of powdered materials.

The friability of most refractories renders the second method difficult of application, and the comparative effects obtained by the use of etching reagents such as hydrofluoric acid are not large enough to discriminate between many of the commonly occurring constituents. Minerals such as fayalite may be distinguished by their reaction with hydrochloric acid, the silica gel which is left absorbing dyes such as malachite green. The main application of this method is in the examination of texture. A flat surface is ground on the material and a glass slip cemented to it by Canada balsam or a coating of transparent varnish applied. Examination by a low-power lens may then be made. In some cases information of value may be obtained by the examination of corroded or fractured surfaces with a low-power lens without any preparation. The author has obtained good results in the photo graphy of such specimens by the use of Aldis lenses of 2 in. and 3½ in. focal length.

The third method is especially useful in the examination of silica bricks and of used alumina-silica refractories.

In the use of the the normal petrographic technique is applied. Occasionally the quantitative determination of various constitutents is of importance; this is especially so in the case of silica bricks where the relative proportions of quartz., tridymite and cristobalite are an important factor in the evaluation of the brick. Sorby estimated the proportion of various minerals in a rock by drawing typical fields and then cutting out of the drawing the different grains and weighing them.

Interesting results have been obtained from the examination of thin sections of refractories which have been in contact with various corrodants. For example, the occurrence of corundum, mullite, felspar, magnetite, may be observed in firebricks or fireclay blocks which have been in contact with molten glass, whilst zinc spinels, and willemite may be seen in fireclay retorts which have been used for zinc smelting.

THE FARADAY SOCIETY.

At the annual general meeting held on July 6, the following Officers and Members of the Council were elected:—

President—Professor F. G. Donnan.

Past-Presidents—Sir Robert Hadfield, Professor Alfred W. Porter, Sir Robert Robertson.

Vice Presidents—W. R. Bousfield, Professor C. H. Desch, Dr. W. H. Hatfield, Professor W. C. Lewis, C. C. Paterson, Professor A. O. Rankine, Dr. E. K. Rideal.

Treasurer—R. L. Mond.

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The report of the Council draws attention to the fact that general discussions on the following subjects were held during 1924:—(1) "Fluxes and Slags in Metal Melting and Working," (2) "Physical and Physico-Chemical Problems Relating to Textile Fibres,' (3) "The Physical Chemistry of Igneous Rock Formation," (4) "Base Exchange in Soils." It is the policy of the Society to co-operate wherever possible with other scientific societies, and three of these discussions were held jointly. The policy of co-operation is also extended to the American Electrochemical Society, in that by a mutual arrangement the transactions of each Society are supplied to the members of the other Society at a special rate. In addition to the general discussions, four Ordinary Meetings were held. One section of the report deals with the convention that should be adopted as regards the sign of the potential on an electrode. The Council was not prepared to make an official pronouncement on the subject, and the opinion is expressed that such matters should be settled by international agreement. During the year 33 new Members were admitted to the Society. There was an adverse balance of £293 7s. 4d. on the year's work, due to the great amount of material published. While loth to diminish the Society's activities, it has been decided to limit the general discussions for the time being to two a year, and it is expected as a result to balance income and expenditure during the present year.

THE INSTITUTE OF METALS.

Papers to be Read on September 2 and 3, 1925.

ROBERT J. ANDERSON, B.Sc., Met.E., AND EVERETT G. FAHLMAN, B.S.—*The Effect of Low-Temperature Heating on the Release of Internal Stress in Brass Tubes.*

PROFESSOR J. H. ANDREW, D.Sc., AND ROBERT HAY, B.Sc., A.I.C.—*Colloidal*

Separations in Alloys.

JOHN S. BROWN.—*The Influence of the Time Factor on Tensile Tests Conducted at Elevated Temperatures.*

L. H. CALLENDAR, B.Sc., A.I.C., A.R.C.S.—*Passivication and Alloys. Scale Resistance in Relation to the Corrosion of Aluminium.*

R. B. DEELEY, A.R.S.M., B.Sc.—*Zinc-Cadmium Alloys. A Note on their Shear Strength as Solders.* (Note.)

J. W. DONALDSON.—*Thermal Conductivities of Industrial Non-Ferrous Alloys.*

PROFESSOR O. W. ELLIS, M.Sc.—*The Influence of Pouring Temperature and Mould Temperature on the Properties of a Lead Base Anti-Friction Alloy.*

MARIE L. V. GAYLER, D.Sc.—*On the Constitution of Zinc-Copper Alloys Containing 45 to 65 per cent. of Copper.*

R. H. GREAVES, D.Sc., AND J. A. JONES.—*The Effect of Temperature on the Behaviour of Metals and Alloys in the Notched Bar Impact Test.*

D. HANSON, D.Sc., AND MARIE L. V. GAYLER, D.Sc.—*On the Constitution of Alloys of Aluminium, Copper and Zinc.*

J. L. HAUGHTON, D.Sc. AND W. T GRIFFITHS, M.Sc., F.I.C.—*The β Transformations in Copper-Zinc Alloys.*

HARRY HYMAN, Ph.D.—*The Properties of Some Aluminium Alloys.*

DOUGLAS H. INGALL, M.Sc.—*The High Temperature-Tensile Curve* (a) *Effect of of Heating.* (b) *Tensile Curves of Some Brasses.*

C. H. M. JENKINS, B.Sc., A.R.S.M.—*The Physical Properties of the Copper-Cadmium Alloys Rich in Cadmium.*

GEORGE BRINTON PHILLIPS. A.B.—*The Primitive Copper Industry of America.*

D. STOCKDALE, B.A.—*The Alpha-Phase Boundary in the Copper-Tin System.*

Messrs Vickers Limited have now acquired the whole interest in the Vickers-Spearing Boiler Co. Mr. A. H. Spearing has resigned his position as managing director, and is no longer connected with the company. The company will be carried on under the name of "Vickers-Spearing Boiler Co., Ltd.," as before. This change also gives Messrs. Vickers Ltd., the control of Messrs Tinkers, Ltd., Daisyfield Boiler Works, Hyde, near Manchester.

NOTICES OF BOOKS.

Journal of the Franklin Institute.

The June issue, among other matter, contains papers by Wilder D. Barcroft, "The Development of Colloidal Chemistry"; by William Lawrence Bragg, "Inorganic Crystals"; by W. Lash Miller, "Concentration of Polarization at the Cathode during Electrolysis of Solutions of Copper Salts"; by W. W. Coblentz and C. O. Lammpland, "Some measurements of the Spectral Components of Planetary Radiation and Planetary Temperature."

A Text Book of Organic Chemistry, Vol. III. Part I. The Alkaline Earth Metals. 346 + XXVI. pp. Price 20s. net. By May Sybil Burr (née Leslie), D.Sc. (Leeds). Edited by J. Newton Friend, D.Sc., Ph.D., F.I.C. London: Charles Griffin and Company, Ltd.

This is a work of considerable importance, not only for the useful information which it contains, but the manner in which it is dealt with. The introduction deals with the elements of the Second Group as a whole, alkaline earths and B zinc groups. Chapter II. is devoted to calcium and its compounds, while Chapter III., IV. and V. deal respectively with strontium and its compounds, barium and its compounds, and radium and its compounds. The various Journals literally referred to throughout the work are given in alphabetical order at the beginning of the book, with the abbreviation of each. There is given a very servicable index for reference.

In his general introduction to the series, the editor, Dr. J. Newton Friend (whose name will be familiar to *Chemical News* readers), says: "No study has progressed more rapidly than Chemistry. It is impossible to write any single text book which shall contain within its two covers a thorough treatment of any one of these branches. The need is rather for a series o text books dealing more or less comprehensively with each branch of Chemistry. One great advantage of this procedure lies in the fact that our knowledge of the different sections of science does not progress at the same rate. Consequently, as soon as any particular part advances out of proportion to others, the volume dealing with it may be easily revised or re-written as the occasion requires. Some method of classifying the elements for treatment in this way is clearly essential, and we have adopted the periodic classification with slight alterations, de-

voting a whole volume to the consideration of the elements in each vertical column, as will be evident from a glance at the scheme in the frontispiece."

Synthetic Hydrochloric Acid.

This is an interesting and useful pamphlet issued by the Castner Keller Alkali Company, Liverpool and elsewhere. The historical aspect of the subject is appropriately dealt with in the opening chapter, and it is pointed out that this acid was prepared in the fifteenth century by Basil Valentine. Glauber, however, regarded it as a rare substance. He discovered its preparation from salt and oil of vitriol, obtaining at the same time sodium sulphate, which became the first stage in the Le Blanc soda process. For years the hydrochloric acid gas was deemed useless and in fact became a nuisance, calling for the intervention of the law. It was not until 1836, when Gossage patented the use of coke towers that the hydrochloric industry really started, and hydrochloric acid became a valuable by-product. Synthetic hydrochloric acid was first produced on a commercial scale in 1912 by the Castner Keller Alkali Company, by the combination of hydrogen and chlorine.

A Summary of Physical Chemistry, by PROFESSOR K. AMDT. 92 pp. Price 3s. 6d. London: Methuen and Co., Ltd.

This concise little book has found a sympathetic translator in Mr. W. H. Patterson (East London College, London University. The author not only states his case, but where deemed needful or useful, quotes authorities. Thus, "The Conservation of Energy: In all changes which occur in Nature, existing energy may take other forms; its sum, however, measured in absolute units, remains unchanged. First law of the mechanical theory of heat. Robert Mayer, 1842; Joule, 1843; Helmholtz, 1847." There is given a subject and also a name index and taken as a whole the work will be found useful, especially by the ambitious student.

The Paper Makers' Directory of all Nations. 984 pp., neatly bound. Price 21s. net. London: Dean and Son, Ltd., 29, King Street, Covent Garden.

The value of this useful publication, now in its 34th year, is considerably enhanced by several improvements. The matter referring to each particular country is alphabetically arranged, which will render reference easy and pleasant. It must have been a work of considerable magnitude to make the necessary amendations in a work of this kind, so as to secure accuracy.

New Patents.

This list is specially compiled for *The Chemical News* by Rayner and Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

17,642.—Jacobson, R.—Method of decomposing metal sulphates by heating. July 9th.

17,542.—Perkin, W. H.—Manufacture of anthraquinone derivatives. July 8th.

17,305.—Sharp and Dohme Inc.—Production of alkyl resorcinols. July 6th.

Specifications Published this Week.

210,095.—Farbwerke Vorm. Meistor, Lucius and Bruning.—Manufacture of bismuth compounds.

213,593.—Geigy Soc. Anon, J. R.—Process of dyeing acetyl-cellulose.

236,086.—Keiser, Dr. K.—Manufacture of formaldehyde.

Abstract Published this Week.

234,192.—Hexamethylenetetramine. - Karpen and Bros., S., 678, West 22nd Street, Chicago, U.S.A.

Hexamethylenetetramine is prepared by the interaction of methylene chloride with liquid ammonia under pressure at an elevated temperature. The ammonia is preferably employed in excess. When the reaction is complete, the excess of ammonia is distilled off and recovered, and the residual mass is treated with a solvent, such as chloroform or carbon tetrachloride, to dissolve the hexamethylenetetramine; the ammonium chloride which remains may be decomposed with hydrated lime and the recovered ammonia employed in the hexamethylenetetramine manufacture.

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458,971.—Carbonate of lime prepared for use as a Fertiliser.—William Gossage and Sons, Widnes, Lancashire. July 15th, 1925.

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455,450.—Nitrogen Bacteria in Solution for use as a Fertiliser.—Thomas Gregorio Tulloch, 2, South Parade, Southsea, Hampshire. July 15th, 1925.

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458,957.—Chemical Substances prepared for use in Medicine and Pharmacy.—F. W. Hampshire and Co., Ltd., Riverside Works, Silk Mill Lane, Derby. July 15th, 1925.

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

CRITICAL STUDIES ON METHODS OF ANALYSIS. XVI.—ZINC.

By LEON A. CONGDON, A. B. GUSS, AND F. A. WINTER.

(Contribution from the Department of Chemistry, Syracuse University)

INTRODUCTION.

(*Continued from Page* 68.)

For an indicator in the ferrocyanide method for zinc, the general custom is to use uranium nitrate solution, made by dissolving 15 grms of this reagent in 100 cc. of water. This was proposed by C. Fahlberg (50) in 1865. F. H. Lyte (51) used uranic acetate in 1873 and states that zinc should be in solution preferably as chloride. W. Herbert Keen (52) likewise prefers uranium acetate as indicator and standardizes the ferrocyanide solution on c.p. Zn. E. Murman (53) used uranyl chloride as indicator. Hermann Weil (54) titrated the zinc in hot solution, using as indicator a 1 to 4 acetic acid solution in connection with 2 cc. of $FeCl_3$ and 20 cc. of potassium tartrate or 30% tartaric acid. By use of this indicator on a spot plate the light yellow colour becomes dirty yellow, then finally greenish blue at the endpoint. G. C. Stone (55) recommends a dilute solution of cobalt nitrate as indicator. F. Moldenhauer (56) found that a 4% solution of copper sulfate placed on filter paper in narrow streaks by a camel's hair brush would give a reddish mark when the free ferrocyanide was placed on the white portion of the filter paper on meeting the copper sulfate narrow streaks. When these filter paper strips are made they must be kept in well stoppered bottles and must be dried quickly. H. Nissenson and W. Kettembeil (57) seem to prefer an indicator a one per cent. solution of ammonium heptamolybdate. W. G. Waring (58) obtained good results by the ammonium heptamolybdate indicator. When this indicator is used, all free H_2S must be absent from the solution titrated. If a blue colour still appears in the test drop, add a crystal or two of sodium sulfite to the zinc solution to decompose any remaining H_2S. Geo. Ewe and Fred Gloor (59) used as the external indicator $WO_2(NO_3)_2 \cdot 6H_2O$ or $WO_2(C_2H_3O_2 \cdot 2H_2O)$, and standardised the ferrocyanide solution against metallic zinc in their estimation of zinc in U. S. P. salts and metallic zinc. E. V. Ericson (60) has used 2 drops of a 0.25% $FeCl_3$ solution as auxillary indicator, finishing with uranium nitrate or ammium heptamolybdate.

Whatever indicator is used for the ferrocyanide process, an allowance should be made for the amount of ferrocyanide in excess of that required to convert all the zinc to ferrocyanide in order to produce the specific colouration with the indicator. To obtain this result or amount, a blank should be made and the volume of ferrocyanide needed should be deducted from the burette reading made in the original estimation of zinc. This correction is not very great, probably not greater than 0.5 cc. in the ordinary standard solutions used.

In all methods using the ferrocyanide volumetric estimation of zinc, it is very important also that uniform conditions are observed in both the standardization and estimation. Nothing must be present which will oxidize or decompose the ferrocyanide solution, and other metals which give insoluble or slightly insoluble ferrocyanides, must be absent if they are present in any considerable amount. Many studies have been made in this connection, especially on zinc ores and alloys of zinc where the separation of interfering elements is necessary. All methods proposed differ on the basis of separation of interfering elements and decomposition of the sample. Geo. C. Stone and W. Geo. Waring (60) in their report of the Committee on Zinc Ore Analysis and results reported to the New York section of the American Chemical Society in

1901 made a very comprehensive study, especially of methods used in separation and determination of zinc by the volumetric ferrocyanide method. Forty-two chemists co-operated, but results in one series of ore samples varied from 55.97% to 59.79%, on another series from 28.90% to 38.56%, and still another series from 12.20% to 39.22% zinc. Some chemists used one method and others different methods as to the separation from the zinc of interfering elements and decomposition of the zinc ores. On this consideration, the methods of procedure were classified into eight groups. The best checks were obtained by the W. Geo. Waring (58) method of separating zinc from interfering elements which is briefly as follows :—The ore is decomposed by acid or fusion and the silica removed. The acid solution is then boiled with aluminium to reduce the iron and replace or precipitate the Pb, Cu, Cd, and Bi. It is then filtered, and the filtrate neutralized exactly, then slightly acidified with formic acid and the zinc precipitated by H_2S under slight pressure. The zinc is then finally determined in the usual manner. A number of chemists again co-operated by all trying Waring's method of separation, but some of the first results showed some analysts had difficulty in getting correct results. Waring and Weber, of the Bureau of Standards, traced the trouble to two sources, the principle one being the necessity and difficulty of exactly neutralising and also sometimes to a partial oxidation of the iron after it had been reduced my aluminium and before the precipitation by H_2S.

Among others who have studied the influence of disturbing agents in the ferrocyanide process for zinc or preparing the ferrocyanide solution are C. Fahlzerg (61), B. C. Hinman (62) ,G. Offerhaus (63), F. G. Breyer (64), V. Lehner and C. C. Meloche (65), E. H. Miller (66), A. Renard(67), E. H. Miller and E. J. Hall (68) L. Blum (69), F. Moldenhauer (70), and E. Oliver (71).

(i) *By Volumetric Sulfide Methods.*—In America, the sodium sulfide volumetric precipitation method, or as it is better known, the Max Schaffner (72) method, for the estimation of zinc has not found much favour on account of the rapidity with which the solution changes its value, since in some laboratories where it is used they find it necessary to run a standard with each sample of zinc material as analyzed.

Just as in the ferrocyanide method for zinc, the zinc must first be separated from interfering elements, and in the case of the volumetric sulfide process for zinc those elements which would be precipitated by a solution of Na_2S. The solution of zinc is made ammoniacal and the standard solution for titration is generally sodium sulfide. Various indicators have been used to show the endpoint of the reaction, the chief difficulty being the clearness of the endpoint.

In Max Shaffner's (72) method, ferric chloride is used as the indicator. In titrating, the same quantities of ferric chloride, HCl, and ammonia are invariably used. The operation is carried out at one temperature, and at the same time ,particularly at the end of the process, when the process shows that the iron begins to assume that characteristic colour which the flakes show at the edges—points which should not be overlooked. In keeping the standard Na_2S, it should be stored in a yellow flask. A mirror should be used to show the reflection of the iron flakes which settle after shaking the liquid.

In C. Kunsel's (73) volumetric sulfide method for zinc, use is made of $NiCl_2$ as indicator used outside of the solution on a test plate until a drop of the solution titrated shows no action on the indicator. According to Groll, the drops of nickel chloride are allowed to flow together on a porcelain plate; while the point of contact shows a blue or green colour, the zinc is not all precipitated, therefore, the sulfide must be added until a greyish black colour appears at contact.

M. Schroeder (74) recommended thallium paper as an indicator in place of lead or cobalt paper in the volumetric Na_2S method for zinc.

A Henniger (75) proposed a process of estimating zinc by the volumetric Na_2S method in 1872. The indicator he suggested was carbonate of lead forced into pores of filter paper by hot pressing.

J. E. Clennell (76) suggested a volumetric sulfide precipitation process for zinc wherein the zinc is precipitated by standard Na_2S and then a slight excess of Na_2S is added, this excess being determined by the following reaction :—

$$Na_2S + 2KAg(CN)_2 = Ag_2S + 2NaCN + 2KCN.$$

In 1917, V. Hassreidter (77) and also W. Orlik (78) studied the modified Schaffner volumetric method for zinc, and both of these investigators found that the average results were trustworthy. W. Orlik defends

the method against the adverse criticism of Patck.

(j) *By Volumetric Thiocyanide Methods.* In 1878, C. Mann (79) brought forth a successful thiocyanate volumetric method for zinc. The method is an indirect one wherein the zinc in solution is first precipitated as a hydrated sulfide. This sulfide is then decomposed with moist AgCl and the $ZnCl_2$ so formed is estimated for chloride by the Volhard method. The materials generally used are wel washed AgCl preserved from light under water; standard $AgNO_3$ solution ;ammonium thiocyanate solution of such strength that exactly 3 cc. is equivalent to precipitate 1 cc. of the Ag solution; ferric indicator; and pure HNO_3. The volume of silver solution represented by the thiocyanate being deducted from that originally used, will give the volume to be calculated to Zn, each cc. being equal to 0.1 gram of zinc. The thiocyanate is cautiously added in the procedure until a permanent light brown colour appears ,which gives the endpoint of the reaction.

In 1921, O. Jander and H. C. Stuhlmann (80) found that the method of C. Mann (79) gave good results.

H. Enell (81) has somewhat modified Mann's method and either Cd or Zn can be estimated. In the case of Zinc as $ZnSO_4$, he adds 10 drops of 10% NH_4OH, then 2 cc .of a 25% copper hydroxide and H_2S water in excess, 1 gram of NH_4NO_3, and then the precipitate is allowed to settle. This precipitate is filtered, washed free from H_2S and placed in a bottle with water and shaken. To this is added an excess of N/10 $AgNO_3$ with HNO_3 and shaken. The precipitate is then filtered again through cotton and washed with water until no test is obtained for Ag.

(k) *Volumetric Oxidation Methods.*—Practically all volumetric oxidation methods that have been suggested for zinc depend first on the precipitation of the zinc quantitatively in some form of sulfide o ras phosphate, arsenate, or carbonate. A few authors have suggested combinations of the volumetric thiocyanate or the volumetric ferrocyanide method with the iodometric method. In this connection, E. Rupp (82) estimated zinc by running a volumetric $K_4Fe(CN)_6$ solution into the neutral solution of the zinc containing 5 grams of sodium potassium tartrate, then letting stand to form $K_2Zn_3(Fe(CN)_6)_2$. After this a considerable excess of N/10 iodine solution is added and the excess titrated with standard $Na_2S_2O_3$ solution.

Geo. S. Jamieson (35) titrates the $ZnHg(SCN)_4$ precipitate, formed by precipitating zinc with KSCN and $HgCl_2$ mixture as precipitant, with KIO_3. Jamieson states that he obtained excellent results, but Cd, Co, Cu, Bi, Mn, and Hg (ous) must not be present. Small amounts of Ni do not interfere appreciably and Fe and As need not be removed ,but ferric iron should be reduced to ferrous.

P. Von Bers (83) studied the iodometric determination of Zinc as sulfide. He added an excess of iodine and determines the excess of iodine with $Na_2S_2O_3$ solution.

O. Jander and H. C. Stuhlmann (80) found that the methods of Pouget and of Knopp depending upon the iodometric determination of the sulfur in the ZnS were more or less unreliable.

M. J. Harnist (84) in his recommendations for the estimation of zinc in the analysis of sodium hyposulfite uses the following. He dissolves 0.01 to 0.05 gram of sample in 250 cc. of water containing enough NH_4OH and NH_4Cl to keep the zinc dissolved. The solution is then heated nearly to boiling and the zinc precipitated as ZnS by a solution of Na_2S. This is filtered and the sulfur in the precipitate is estimated by the usual iodometric method.

A. Renard (67) determined the excess of potassium ferrocyanide in the titration of zinc by standard $KMnO_4$.

Schwarz (85) estimated zinc volumetrically by precipitation as sulfide and subsequent titration with ferric salts and permanganate standard solution.

H. Bacovescu and E. Vlahuta (86) indirectly estimate zinc, cobalt, copper, nickel orlead by taking the soluble salt and treating with a slight excess of freshly precipitated $MnCO_3$, the zinc or other elements mentioned being precipitated as carbonate. The excess of $MnCO_3$ and the $ZnCO_3$ is filtered off and titrated with standard H_2SO_4 The excess manganese in the precipitate is found by means of standard $KMnO_4$ in accordance with Guyard's reaction :—

$$3\,MnSO_4 + 2\,KMnO_4 + 2\,H_2O =$$
$$5\,MnO_2 + K_2SO_4 + 2\,H_2SO_4.$$

This reaction has been found to be conducted with a greater degree of precision in the presence of zinc salts. Thus the zinc can be readily calculated in the $ZnCO_3$ precipitate.

P. Artrann (87) indirectly estimates zinc volumetrically by first precipitating the zinc as $ZnNH_4PO_4$, dissolving this precipi

tate in H_2SO_4, adding NaOH in excess until the precipitate redissolves, then adding N/2 NaOBr solution in excess and titrating for the excess with standard iodine solution.

R. K. Meade (88) determines zinc as the arsenate by precipitation of the zinc first as zinc ammonium arsenate, dissolves in HCl, adds KI, and titrates the liberated iodine with standard $Na_2S_2O_3$ solution.

J. Valentin (89) precipitates zinc as the arsenate by standard solution of K_3AsO_4 and the excess titrated in an aliquot of the filtrate.

H. C. Ward (90) estimated Zn, Pb, and Ni by first precipitation as oxalates, the oxalates dissolved in H_2SO_4 and titrated with standard $KMnO_4$.

(l) *Volumetric Neutralisation Methods.*—The volumetric neutralisation methods for zinc that have been suggested can be divided into direct and indirect methods. Direct methods comprise those where the zinc is free from other metals and in the form of oxide, carbonate, sulfide(chloride, or phosphate. Indirect methods take up those where interfering elements are removed, then the direct methods are applied. The principle involved is the replacing of a weak acid radical by a stronger one and measuring the amount o fstandard acid required to do this, thereby determining the amount of zinc present.

Benedikt and Cantor (91) devise a method for the estimation of zinc by treating the oxide or carbonate with standard H_2SO_4 using phenolphthalein as indicator.

Percy H. Walker (92) based a neutralisation method upon the following reaction using methyl orange as indicator:—

$$ZnNH_4PO_4 + H_2SO_4 = ZnSO_4 + NH_4H_2PO_4$$

W. Vaubel (93) determines Zn, Cu, and Co employing ammonia by neutralisation volumetric process using phenolphthalein as indicator.

R. Howden (94) titrates zinc as the chloride using standard NaOH, first with methyl orange then with phenolphthalein as indicators. The chloride must be free from other heavy metals or ammonia.

I. M. Kolthoff and J. K. Van Dijk (95) find that both the direct and indirect acidimetric methods of determining zinc are accurate within 1% if carried out properly. O. Jander and H. C. Stuhlmann (80) state that the methods of Houber and of Taylor depending upon the determination of the acid required to dissolve the ZnS precipitate were found more or less unreliable. They also found that Mohr's method based upon the reduction of iron by the ZnS in presence of acid was also uncertain.

(m) *Volumetric Potassium Cyanide Methods.*—H. Grossman and L. Holter (96) showed that zinc can be titrated volumetrically with standard KCN, the value of which is determined by titration against a known amount of c.p. zinc. The KCN solution is added in excess and the excess estimated by KI and $AgNO_3$ in NH_4Cl solution, which in turn has been standardisez against the KCN. The addition of the KCN to the zinc solution forms the soluble zinc potassium cyanide, but the excess of cyanide is found by forming an opalescence of silver cyanide. The amount of KCN used by the silver is, of course, deducted from the total KCN added and hence the value of the zinc estimated. All metals which form a cyanide complex with KCN must be absent, and in the case of zinc, it must be titrated in neutral solution on account of hydrolysis of the insoluble zinc cyanide. E. Rupp (97) also studied the estimation of zinc and also lead by direct titration with KCN. W. B. Treadwell (98) studied the estimation of zinc by the cyanide volumetric process, and states that ammonia salts in excess or acetates must not be present and the solution titrated must be neutral by titration with KCN using methyl orange as indicator. The solution should be cooled to 15°-20°, then 1 gram of NH_4Cl added and titration made with N/2 KCN until the precipitated zinc cyanide with shaking just dissolves and forms the soluble potassium zinc cyanide. Treadwell states further that the method of Grossman and Holter (96) is incorrect in principle, since it is shown by electrometric measurements that a greater cyanide concentration is required, owing to hydrolysis, to retain $Zn(CN)_2$ in solution, than to dissolve AgI. Treadwell claims his modification of Rupp's (97) method is more accurate, as he obtained more accurate results than with the Grossmann and Holter method. In case ammonia salts in excess or acetates are present in the zinc solution to be estimated, Treadwell recommends the Waring method of separation of the zinc by H_2S in the presence of formic acid in dilute N_2SO_4 solution.

EKA- AND DIVI MANGANESE.

By Walter Noddack and Ida Tacke.

Chemical Part.

Among the blank spaces in the Periodic Classification, two of the missing elements having the numbers 43 (Bausanquet and Keeley, *Phil. Mag.*, 1924, XLVIII., 145), and 75 occur under manganese. It has become obvious (Loring, *this Journal*, 1922, CXXXV., 306, 386), that both these

elements exist in minute quantities if at all. Evidence in support of this has been adduced and is presented in the reference cited.

The present contribution gives an account of our researches to discover eka- and divi-manganese. The most important geological and chemical properties are given first.

Introduction.

Occurrence. Concerning the occurrence of these two elements, many suppositions have been advanced. In the first place, both should resemble one another and be found together as in the cases of Y and La; Zr and Hf; Nb and Ta; Mo and W; and Ru and Os. Their discovery should, therefore, be simultaneous, and for this it is necessary to find a suitable mineral in which they would be likely to occur. For this there are two possibilities. Either the elements would be found in a specific and new mineral, or they might occur in company with other elements in minerals already known. The first possibility seems improbable so far as the earth's crust is concerned. Our investigations have, therefore, started with the second alternative in mind.

For the combined occurrence of numerous metals (from Sc to U, with the exception of the alkali- and alkali-earth metals), there are two large central groups (*a*) massive occurrence, *e.g.*, platinum ores, (*b*) occurrence as oxide, *e.g.*, columbite or tantalite.

Platinum ores contain chiefly Pt and Fe but include small percentages of Cr, Mn, Co, Ni - Ru, Rh, Pd, Os, Ir - Cu, Ag, Au —a very compact set of elements when viewed from their positions in the Periodic Table.

Columbite and tantalite contain Fe, Nb, Ta, together with appreciable amounts of Ti, V, Cr, Mn, Zn, As, Y, Zr, Sn, W, Pb, and U, and small amounts of (0.001 - 0.1%) of Sc, Ga, Ge, Mo, Cd, In, Sb, La and the earths, Hf, Bi, and Th.

These elements in columbite flank those of the platinum ores. Both these, therefore, seemed possible sources for the elements 43 and 75.

Abundance or Frequency. By reference to the Periodic Classification, it will be noticed that chemical properties change markedly from element to element in the neighbourhood of eka-manganese. It is also seen that the two new elements follow two already well-known, thus resembling the case of Hf and Zr.

All these observations and deductions suggest that the amount of the two missing elements in the earth will be low. They also possess odd atomic numbers, and it is noteworthy that a similar drop in the amount is noticeable with all elements of odd atomic number. In general, elements with odd atomic numbers are 10-20 times more rare than the elements immediately following them.

On the assumption of the abundance (amounts) of Ru and Os compared with Mn and Fe, it seemed likely that the new elements should have an abundance of about 10^{-12} to 10^{-13} of the earth's crust. This estimation has, however, no definite value but serves to indicate the degree of probability of their abundance in certain minerals.

The abundance of Pt is 10^{-9} and thus the amount of 43 and 75 in Pt ores should be from 10^{-3} to 10^{-1}.

Niobium, the chief constituent of columbite forms 10^{-7} of the earth's crust, and this mineral was thus estimated to contain from 10^{-5} to 10^{-6} of the new elements.

Some Physical Properties. Since 43 stands between Mo (at. wt. 96.0) and Ru (101.7), its atomic weight should lie between 98.0 and 99.5. Similarly 75 is between W (181.0) and Os (190.9) and its atomic weight should be about 187-188.

The probable density of the missing elements may also be derived from those of Mo (10.2) and Ru (12.26) which should be about 11.5 for No 43, while that of No. 75 should be about 21 as those of W and Os are 19.1 and 22.48. The respective melting points should be 2,300° and 3,300° absolute.

Chemical Properties.

From the properties of the surrounding elements, Cr, Mn, Fe, Mo, Ru, W, Os and U, it is possible to predict with tolerable certainty a number of chemical properties possessed by the unknown elements.

Oxides. The lower oxides of eka- and divi-manganese should have the formulæ XO, X_2O_3, and XO_2, and be dark and insoluble in acids. On the other hand, XO_3 corresponding with CrO_3 and MoO_3 should be of light colour and dissolve in water, behaving as the anhydrides of the acids H_2XO_4.

Of greater interest, however, are the

higher oxides corresponding with Mn_2O_7. By intrapolation between the volatile oxides, MoO_3, m.p. 790° and RuO_4 m.p. 21° the oxide X_2O_7 of No. 43 should melt at from 350-400° and vaporise at a point not much higher. Similarly the highest oxide of No. 75 should have a m.p. about 400-500° and a similar sublimation temperature.

Since CrO_3 is dark red, Mn_2O_7 is violet, MoO_3 on heating is yellow, and RuO_4 is orange, X_2O_7 (43) should be rose coloured or yellow and that of 75 intermediate between WO_3, yellow, and OsO_4, colourless, should be pale yellow or white. In molecular structure, X_2O_7 should take the form of monoclinic or triclinic needles.

Salts. Since all the neighbouring elements form white salts of the type $MeXO_4$, 43 and 75 should form similar ones, and in addition, acid salts of the type $Me_2O.(XO_3)_2$, analogous with the bichromates. Analogous with $KMnO_4$, salts* of the type $MeXO_4$ should exist, but these would be less stable—RuO_4 and OsO_4 are not able to yield stable salts with alkalis. Heavy metal salts of the acids HXO_4 should be soluble with difficulty and it is impossible to make any prediction concerning the heavy metal salts of HXO_4. Mercurous nitrate should form precipitates with solutions of these salts.

Sulphides. In the Periodic Table there is a noticeable demarcation between the first horizontal series and the second and the third. Ti has many similarities with niobium and Ta, V with Mo and W, Mn with Ru and Os. It is therefore reasonable to assume that eka- manganese will show resemblances to Cr, which forms no insoluble sulphide in aqueous solution (only in concentrated solutions of Cr salts and under high pressure is CrS formed). Thus its power of forming sulphides will be between that shown by V and Mn. If the sulphides of eka- and divimanganese are formed at all it will be with difficulty in solution.

SEARCH FOR THE MISSING ELEMENTS.

Procedure. The conjectured properties of the elements suggested the procedure adopted in these researches.

The finely powdered minerals were fused in 1 kg. lots with KOH and KNO . The product of fusion was treated with water and the soluble part filtered off. This removed most of the Fe. The contained Mn which was precipitated by treatment with H_2O_2 The solution contained appreciable quantities of acid-forming oxides (*e.g.*, from chromite). It was therefore acidified with HCl and evaporated to dryness. The residue was shaken up with concentrated HCl and the solution was reduced to the minimum bulk (10—50 cc). This solution contained only small quantities of the heavy metals and was treated in acid and in alkali with H_2S until no more metal sulphide separated. The solution was then acidified with HCl and the chlorides thrown down on standing were removed.

The elements sought should still be in the solution. This was again treated with H_2S. All precipitates were examined together. We made a survey of the elements which are not quantitatively precipitated by H_2S. They are Ti, Zn, Ga, Nb, W, Os, Ir, and U.

The solution was precipitated again first in presence of acid and finally in ammonia, and then re-acidified. The filtrate was freed from H_2S and NH_3, neutralised, decomposed with excess of $HgNO_3$. This caused the separation of a small amount of a precipitate which was dried, and heated in a stream of H and thereby freed from Hg. All the sulphides and the Hg precipitate were analysed and their composition was determined.

The principal metallic constituents were removed and the product made richer in the two new elements.

In another process quantities of about 500 gr. of the finely powdered minerals were heated alternately in currents of H and O at 900 about yielding small sublimates. According to the quantity these sublimates were either analysed chemically or were kept for X-ray examination.

RESEARCHES ON INDIVIDUAL MINERALS.

The Pt ores were the first to receive our attention. We examined osmiridium, Sperrylith, $PtAs_2$, unfortunately not Laurite, RuS_2 owing to scarcity of material.

We have also examined all the Columbite and Tantalite we could obtain, including minerals rich in columbite, viz., titaniferous iron, rutile, vanadium, gadolinite, fergusonite, monazite, zircon, tinstone, and the heterogeneous minerals chrome ironstone, pyrolusite, manganese blende, zinc blende ,arsenical pyrites and stibnite.

We began with Russian Pt ores, of which about 80 gr. were available. It was treated with aqua regia, and the solution taken to dryness. The residue was reduced in a stream of H, the reduced substance, together with the unaffected part, was then strongly heated alternately in currents of H and O. In this way a large amount of OsO_4

mixed with some RuO_4 distilled over.

On the sides of the quartz tube a strong black deposit of RuO_4 appeared.

A noticeable white sublimate of As_2O_3 and a very small deposit of microscopically small needles were also obtained observed. On the introduction of H_2S these darkened, apparently through the formation of the sulphide whi ch decomposed on introduction of O and heating, and small white crystals were formed on the cool parts of the tube. They dissolved in water. The solution reacted acid and gave no precipitate with H_2S or $(NH_4)_2S$.

As such behaviour was to be expected from the elements 43 and 75 and from none of the other known elements in the solution, this was assumed to contain the missing elements. The concentrated H_2S solution was yellow and left behind hardly any residue on evaporation.

No success was obtained by heating osmiridium in O, although small quantities of the sublimate were obtained. However, in attempting to remove the heavy metals, the material was lost.

As our Pt ore was exhausted and fresh supplies were not forthcoming, we turned our attention to the oxide minerals, such as columbite, which should contain only 10^{-6} of the new elements.

About 1 kg. of columbite was fused with NaOH and $NaNO_3$ to remove the bulk of the Fe Nb and Ta (as niobate and tantalate). The filtrate was treated as outlined above. $HgNO_3$ gave altogether about 1 gr. of precipitate estimated to contain about 1 per cent. of the new elements. X-ray analysis showed thede was less of 43 than of 75.

The reduced precipitates were re-treated to remove more of the associated elements. In this manner the concentration of the new elements reached about 0.5% for 43 and about 5% for 75, contained in 20 mgms of material.

Reheating in a stream of O again produced some of the white precipitate sublimate. The quantity was, however, too small for direct application to the anticathode for X-ray analysis. It was therefore mixed with niobic acid and when examined in this manner gave the lines of the element 43.

Investigations upon some other minerals including Sperrylith, gadolinite, and fergusonite yielded minute quantities of 43. Traces of 75 have been found in tantalite and wolframite.

RESULTS OF THE INVESTIGATION.

From our researches it is evident that both homologues of Mn exist in the earth. Both are present in columbite to the extent of 10^{-6} to 10^{-7}. Their properties must be essentially as outlined above.

Their identity has been established by X ray analysis. Further experiments will be made when more material is available.

(From *Die Naturwissenschaften*, June 26, 1925, p. 567.)

The *X-ray Examination* has been carried out by OTTO BERG AND IDA TACKE, who examined the enriched preparation containing the elements. Traces of the new elements were also observed spectroscopically in various minerals. The lines $K\alpha_1$, $K\alpha_2$ and $K\beta_1$ of No. 43 were measured as were $L\alpha_1$, $L\alpha_2$, $L\beta_1$ and $L\beta_2$ of No. 75. The names suggested for the new elements are "Rhenium," and "Masurium."

VALENCY RELATIONS.

In his noteworthy article on the above subject (this Vol. p. 50) Mr. F. H. Loring appends a note to the effect that I have rendered him assistance in pointing out certain compounds which accord with his comprehensive scheme. We had, it is true, discussed the valencies exhibited by certain elements, but all the credit is due to Mr. Loring. My opinion was asked regarding unusual valencies and whether the existence of formulæ of certain oxides and haloids was definitely established.

The full title of the paper was "Valency Relations: An Element o Atomic Number Zero with an Atomic Weight Unity," and the second part recalls his studies on the probable existence of an element of atomic number zero (*see* this Journal, 1923, CXXVI., 307, 325, 371).

It will be noted that Mr. Loring has assigned the valencies 1, 3, 7, to the elements No. 43 and No. 47, which fits in with the views of Noddack and Tacke, who claim the discovery of these elements which they have called Rhenium and Masurium.

The missing element No. 61 among the rare earths is, together with these bodies, omitted.

It will also be noted that zinc is assigned a lower valency of one. I am unaware of any compound of zinc in which the metal clearly shows this valency, but this does not preclude the possibility of one being discovered.

The scheme presented by Mr. Loring has apparently been developed from the ideas expressed in his early book "Studies in Valency," 1918 (price 8s. 6d.), reviewed in this Journal at the time. He then suggested that ZnO might have the polymeric formula

$$\begin{array}{l} Zn-O \\ \quad\;\;| \\ Zn-O \end{array}$$

the zinc atoms tending to break valencies and become monatomic at higher temperatures, and in this connection the colour change shown by this body on heating points to this possibility.

The question of valency in the cases of the oxides or even the haloids presents well-known difficulties on account of mutual association of the halogen, or oxygen atoms amongst themselves, apart from their linkages to the metal atom, for example. But Mr. Loring's scheme is not rigid throughout, so that RuO_4 and OsO_4 may represent octavalent metals in this instance, while the modification necessary to bring about this change involves other readjustments of adjacent values. Similarly, Cr may be raised to 6.

Mr. Loring regards the neutral atom of atomic number zero as a real entity and he has found several ways of predicting its existence. The incredible smallness of this atom, as based on Rutherford's nucleus, makes it possible for it freely to penetrate solid matter, and Mr. Loring regards the recent ether-drift experiments of Professors Miller and Michelson (and Dr. Gale) as possibly influenced by the pressure effect involved by this neutral gas, sweeping through matter very much as the ether was credited with this property. This, Mr. Loring informs me, leaves Relativity "untouched," if the drift effect is due to a subsidisary phenomenon as suggested.

J. G. F. Druce.

INTERESTING SCIENTIFIC RESEARCH WORK IN DEMARARA.

Sir John Harrison, C.M.G., M.A., F.I.C., Director of Science and Agriculture at George Town, Sheds Light on the Cause of an Old Explosion.

In the *Chemical News* of May 29, 1925, page 344, we published a brief note of a very interesting investigation in connection with a peculiar explosion in 1916 in an abandoned gold quartz mine. The investigation took place early this year, and in furnishing the memoranda specially to the *Chemical News*, Sir John Harrison says :—

"I have been a subscriber to the *Chemical News* for fifty years, and a reader of it five years preceding my regular subscription to it."

Several difficulties had to be overcome before the experiment referred to could be carried out. Sir John says it was impossible to obtain samples of the gas which produced the explosion. Upon personal examination of the mine I could find no indication acceptable to general ideas of the occurrence of fire-damp therein. I formed a theory, and to test whether or not that theory was reliable I took samples from the actual mining timbers at the site of the explosion and placed them under similar conditions to which they had been during the time the mine was water-logged. I proved that mining timbers under water in anærobic conditions evolved fire damp.

The analysis of the gas gave the following results :—

Temperature 8° C. = 82.4° F.

Hydrogen	29.6
Methane	5.76...
Ethane	Nil
Oxygen (free)	Nil
Carbonic oxide	Nil
Carbonic anhydride... .	8.4
Nitrogen	8.8
Water vapour	1.1

The gas was therefore a mixture of approximately two volumes of methane (light carburetted hydrogen or marsh gas) with one of hydrogen and contained in addition about 10 per cent. of carbonic acid gas with a small proportion—8 per cent. of nitrogen probably derived mainly from the nitrogen dissolved in the water with which the jar was filled.

The residual gas in the jar after making the various tests and completing the analysis, was ignited in the presence of the Commissioner and Assistant Commissioner of Land and Mines, and of Mr. R. Ward, M.B.E., the latter of whom, as mentioned earlier, was present during the official inspection of the mine after the accident. A gush of flame arose to the height of over four feet. This demonstration completed the inquiry.

Discovery of a New Mineral.

Sir John Harrison also sends us particulars of the discovery of a native Palladium Mercuride in British Guiana.

The mineral in question is, according to

high authorities in mineralogy, a hitherto unknown and unique one. Its greatest peculiarity is its very high density—15.37 in my most perfect specimen. This high density is a characteristic of a compound of approximately 35% of palladium and 65% of mercury. This density points to a very extraordinary molecular condensation having taken place during the combination of the palladium and the mercury. The other characteristic mineral in alluvial deposits in which the Palladium Mercuride is found is diamond.

CRITICAL POTENTIALS ASSOCIATED WITH EXCITATION OF ALKALI SPARK SPECTRA.

By F. L. MOHLER.
(*Bureau of Standards, Washington, U.S.A.*)

ABSTRACT.

Various forms of electron tubes used in this work are described, including a new type of tube suitable for spectroscopic study of discharge with very low current density. Experimental results are as follows:

Rubidium. — Electrical measurements show critical potentials for production of radiation at 16.0 and 21.6 volts and with less certainty at 18.0., 25.2., and 68 volts. There is an increase in ionization at 16 volts. Spark Lines are excited near 25 volts with small currents and at 16 volts with high-current density.

Cæsium.—Spark lines are excited with small currents at 21.5 volts and with large appears above 40 volts. A table of lines and intensities is given.

Potassium. — (Published results give radiation potentials at 19 and 23 volts.) There is an increase in ionization at 19 volts, and spark lines are excited at this point with high curent and near 28 volts with low currents.

Sodium.—The spark lines appear near 35 and 44 volts, with large and small currents, respectively.

Lithium.—There is a critical radiation potential at 54 volts, and a spark line appears near this point.

Conclusions. -- The potentials Li 54, Na 35, K 19, Rb 16, Cs 14 measure the work required to remove a single electron from the rare gas shell of the normal atom. Each of these values is equal within experimental error to the ionization potential of the neighbouring rare gas ion. The critical potential for low-current spark excitation gives the work required to remove two electrons by a single collision. The potentials K23 volts and Rb 21.6 volts apparently measure the work required to remove the second electron from an ion with the valence electron removed.

It is shown that the first critical potential above the arc limit measures the work required to ionize the atom from the rare gas shell. This energy level is in each instance equal to the corresponding level of the neighbouring singly charged rare gas ion. The failure to detect radiation potentials below this ionization potential suggests that the excitation process is of the type involved in X-ray emission.

Double excitation of an alkali atom may be effected by a single electron impact, but with current densities greater than a few hundredths of an ampere per square centimetre excitation by successive collisions also takes place. From the observed minimum potentials for these two types of excitation we compute the limiting frequency of the ion spectrum.

Cæsium has a second spark spectrum which is excited between 40 and 80 volts. Apart from this, the observed lines of each enhanced spectrum appeared at the same potential, or at least within a range of about 2 volts.

ON THE TRANSFORMATION TEMPERATURE OF THALLIUM

By GENSCHICHI ASAHARA.

(*Abstracted from a Scientific Paper published by the Institute of Physical and Chemical Research, Tokio.*)

Thallium has been known to exist in two enantiotropic modifications and the transformation temperature has been measured by various investigators with the result that the agreement among themselves is rather far from satisfaction. As most of the workers happened to observe this singular temperature in the course of studies of binary alloy systems containing thallium and apparently laid not much stress in this respect, the discrepancy seems to have escaped being brought to argument. Most measurements of the transformation temperature by thermal method were made using too small a quantity of the material, value in contributing some knowledge with While a precision measurement of the transformation temperature is necessary in view of furnishing a reliable value, it is also of so that the accuracy was often lacking. regard to the phenomenon of allotropy. It is of interest as well to see how the determination comes out in comparison with the value observed by the new X-ray method

described elsewhere by the present author. The object of the present investigation is to carry out as accurate a measurement as possible following the method of thermal analysis by using a considerable quantity of the metal of very high purity and paying special attention to the experimental arrangements.

SUMMARY.

1. The transformation temperature of pure electrolytic thallium was measured by means of thermal analysis with considerable precision. The mean of each twenty-four observations gave respectively the value $232.6_9°$ on heating and $232.3_9°$ on cooling, the final mean of the two giving the value $232.5 - <0.5°$ for the transformation temperature.

2. The nature of the small second maximum point observd in the inverse-rate heating curves has been discussed at length and the origin of this peculiarity was attributed to the particular distribution of temperature in the specimen metal due to the propagation of the transformation. The process of the transformation has been considered from the study of the second maximum.

HIGH TEMPERATURE PIPE COVERINGS.

By A WELL KNOWN ENGINEER.

From a chemical point of view a particularly interesting question is that of covering boilers, pipes, and general chemical plant operating at high temperatures so as to prevent loss of heat. It is extremely difficult to find a material that is a good non-conductor of heat and at the same time is sufficiently resistant to maintain the mechanical and cellular condition which gives it the heat insulating properties because of imprisoned air cells.

The opening of the first section of the new Barking power station, with 375 lbs. gauge pressure and 725° superheated steam temperature, is a reminder of the problems that have had to be faced in this connection with steam boiler practice under modern superpower station conditions including a superheated steam temperature of 700° F. or over. It is not very long ago that 600° F. was the standard practice, and most electricity stations in the world to-day still do not exceed these figures. This rise of only 100° F. has, however, resulted almost in a revolution so far as boiler and pipe coverings are concerned, ruling out almost every covering hitherto regarded as of the highest quality. Thus, 85% magnesia (85% magnesium carbonate and 15% asbestos added as a binder) begins to calcine at these higher temperatures, and cannot be employed as a self-covering at over 600° F. As indicating the latest high-temperature practice, of particular interest in the "Caloperite" material of Messrs. Sutcliffe Bros. and Bryce, Ltd., of Hyde, near Manchester, which is guaranteed to stand a continuous temperature even as high as 1,000° F. without difficulty, whilst at the same time saving 90% of the heat loss. That the material is quite satisfactory under these severe conditions is proved in the first place by the fact that it is used in the iron and steel industries for covering hot blast mains with an average continuous temperature of 800° F., and a maximum of 900° F., and there is no sign of disintegration or loss of non-conductive properties after many months of running.

In addition, also, detailed tests carried out by the Engineering Department of the University of Manchester, have shown that 12 hours' exposure to a steam pipe internally heated to 1,000° F., has no deleterious effect, whilst National Physical Laboratory tests with only 1.6 inches of "Caloperite" on a pipe at 157.4 lbs. steam pressure and 369° F., temperature indicates a saving of 83.2% of the heat radiated from a bare pipe. For the most severe conditions, therefore, a slightly thicker layer of impervious "Caloperite" only can be used, saving 90% of the heat, or, in the case of superpower station steam conditions, a half-inch layer may be placed next to the heated surface to withstand the first shock of the heat, and the job finished off with, say, 85% magnesia or asbestos covering, thus saving up to 96% of the heat loss.

Modern research work in pipe covering proves conclusively that for ordinary industrial conditions the good grade material, which does not cost very much more than inferior clay and fibre compositions, is very much the best value, especially in view of the fact that the nett saving in the coal bill is much greater and the disintegration of low quality material is apt to me much more severe than generally imagined after a few months' continual contact, even at low steam pressures.

Also each job has to be considered on scientific lines and the right covering supplied for the particular conditions from the point of view of capital outlay, amount of heat saved, and resistance to disintegration, the use of one material only, irrespective of the conditions, not being on correct lines.

General Notes.

OLD READERS OF *THE CHEMICAL NEWS.*

There are few scientific papers in the world that can boast so many old readers as *The Chemical News* (which, as readers are aware, was founded in 1859, by the late Sir William Crookes, O.B., etc.). Its foreign subscription list extends to about 1,000 in all parts of the world, of which over 100 are in Japan. We are reminded of the favour in which it has always been held by scientific men by the letter just received from Sir John Harrison, C.M.G., M.A., F.I.C., Director of Science and Agriculture at George Town, Demarara, who says he has been a subscriber for 50 years and a reader for five years before becoming a regular subscriber. We appreciate his letter very much and also his long patronage of *The Chemical News.*

It will be our aim in the future to deserve the support of all old as well as new subscribers and to steadily enlarge the circle of readers.

CANADA LEADS IN COBALT PRODUCTION.

The High Commissioner for Canada in London has received from the Dominion Department of Mines, the following article dealing with cobalt production in Canada:

" Canada holds the record as the world's largest producer of cobalt, all of which comes from mines in the province of Ontario.

It was not until 1903 that the big find was made at what is now the town of Cobalt, Ontario, during the construction of the construction of the Timiskaming and Northern Ontario Railway, although a small tonnage of cobalt was reported from the nickel-copper ores of Sudbury for the years 1892 to 1894 inclusive. To date about £2,875,000 worth of cobalt and its compounds have been produced. This yield has been obtained almost entirely from the silver-cobalt nickel ores of the cobalt area. Formerly there were several firms engaged in treating cobalt ores, but at the present time there is only one company on the American continent engaged in the reduction of these ores, the Deloro Smelting and Refining Company, Ltd., which operates a very complete plant at Deloro, Ontario.

In 1924 the estimated Canadian production of cobalt products in the form of metal, oxide, salts, and residues, was equivalent to 960,266 pounds of contained metal, for which the producers received £344,584.

In the same year, 170,513 pounds of metallic cobalt, valued at £78,486, was exported, also 2,421 pounds of cobalt alloys, valued at £2,450, and 490,505 pounds of cobalt oxides and salts ,valued at £186,473, making a total value of £267,408.

Some cobalt colours are imported for use in the ceramic industry, but the statistics are not segregated."

ITALIAN FOREIGN TRADE.

The British Commercial Secretaries at Rime, in their report on the commercial, industrial and economic situation in Italy, state that that the shares of the chief countries trading with Italy were as follows :— The United States, 5,880 million lire; the United Kingdom, 3,669 million lire; France, 3,301 million lire; Germany, 3,083 million lire; Switzerland, 2,023 million lire; Argentina, 1,936 million lire; Austria, 1,147 million lire; Jugo-Slavia, 927 million lire; and Czechoslovakia, 446 million lire.

AUTOMATIC PETROL SUPPLY APPLIANCES IN POLAND.

The British Consul at Warsaw reports on the subject of the installation of appliances used in connection with automatic petrol supply stations for measuring the amount of petrol consumed that such appliances can only be used publicly in Poland after each type has received the approval of the Head Office of Weaghts and Measures, the exact style and adddress of which are :— Glówny Urzad Mjar, Elektoralna 2, Warsaw.

ROUMANIAN RADIO-ELECTRIC LAW.

The British Commemrcial Secretary at Bucharest has forwarded a translation of the Law for the installation and use of Radio-Electric Posts and Stations in Roumania, and which was duly published in the "Monitorul Oficial " No. 147 of 8th July.

British firms interested may consult the translation referred to on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

CANADIAN CHAMBER OF COMMERCE IN LONDON.

According to the fourth annual report of the Executive Council of the Canadian Chamber of Commerce in London, the membership of the Chamber is now 172, as compared with 151 a year ago. This is made up of four life members, 109 active members, and 59 associate members. The President of the Chamber, in his annual address to the members, referred to the visit of the delegation of the Canadian Manufacturers' Association to this country during the past year, and to the opening of the new Canadian Government building in Trafalgar Square by his Majesty the King. He also welcomed the statement made by Sir Philip Cunliffe-Lister, President of the Board of Trade, in his appeal to develop the demand for "British-made" goods. This, he stated, is a necessity to British industry, and he earnestly expressed the hope that the policy of the British Government will very shortly be that, failing home manufactures, the products of our Empire should then be given first consideration. Conditions in Canada were, he thought, improving, and he was confident that a great field awaits the British manufacturer who seeks a new export market. He would suggest to those who are interested in this new field the value of the Canadian National Exhibition, which holds its fair during the last week in August and the first week in September each year.

THE INDUSTRIAL PROBLEM IN CZECHOSLOVAKIA.

European observers who have had the opportunity of observing Czechoslovakia's persistent efforts to consolidate her economic and financial position in Europe have long realised that, as in the case of England, her real problem lies in the finding of foreign markets for an industry which is far too large for the needs of her home population. By the various Peace Treaties, Czechoslovakia inherited approximately 80 per cent. of the total industry of the former Austro-Hungarian Monarchy. Under the Monarchy this industry, amply protected by a generous tariff, had a home market of over 50 millions of people. To-day, this home market has been reduced to less than fourteen millions. In other words, an industry which formerly disposed of some 80 per cent. of its production in home markets and sent only 20 per cent. abroad has, through the force of new circumstances, entirely reversed its position, and to-day approximately 75 per cent. of the total production of this vast Czech industry has to find its outlet abroad. In the state of economic stagnation and depression in which Europe is now situated, this is a gigantic task, even for a country so rich in natural resources as Czechoslovakia. A short review of Czechoslovakia's industrial record during the past six years will help to show how far she has succeeded in finding a solution for this problem.

The history of post-war industry in Czechoslovakia may be divided into three periods; first, the period of inflation and industrial expansion from 1918 to 1921; secondly, the period of acute depression produced by the world slump and aggravated by the deflation policy of the Czechoslovak Government. This period lasted from November, 1921, until the autumn of 1923. The third period from October, 1923, until the present moment has been characterised by slow but unmistakable signs of recovery.

THE FIELD PROGRAMME, 1925, OF THE GEOLOGICAL SURVEY, CANADA.

The High Commissioner for Canada in London has received from the Dominion Department of Mines at Ottawa the following article relating to the field work being carried on this year by the Geological Survey Branch:—

The Geological Survey of Canada has about fifty parties engaged in field work this summer at different points throughout the country from the Atlantic to the Pacific. Many of these are engaged in geological investigations and others in the preparation of maps for future geological work. Stress is being laid on the direct economic features of the work and attention is being turned to areas where mineral discoveries have been made and where assistance may be rendered to those engaged in their development or to those engaged in search for other deposits; also to areas where geological conditions are such as to favour the occurrence of economic minerals.

CORRECTION.

Our attention has been drawn to a typographical error in the article by John Malpas, Esq., entitled, "The Business Value of Chemistry in Education," in our issue of July 31, 1925.

The words "*than the chemical side,*" should be deleted from line 11, column 1.

GEOLOGICAL SOCIETY OF LONDON.

June 10, 1925, Dr. J. W. Evans, C.B.E., F.R.S., President, in the chair.

The following communication was read:

On some Occurrences of Spherulitic Siderite and other Carbonates in Sediments, by EDMONDSON SPENCER, B.Sc., Ph.D., F.G.S.

The author gives descriptions of a number of spherulitic aggregates (many of which have been described as oolitic) in freshwater clays and in coals. The occurrences, which are considered in detail, include those in the Fairlight Beds, the Upper Coal Measures of Staffordshire and South Wales, the Upper Wankie Sandstone Series (Rhodesia), and the coals of the Damuda Basin (India). For comparison with these, spherulites with radiolaria from Santo Domingo (Portugal) are described.

The spherulites are composed of rhombohedral carbonates, usually siderite, but occasionally of calcite, sideroplesite, dolomite, or a mixture of manganese and iron carbonates (as at Santo Domingo). By treating thin slides of the spherulitic siderite (after heating to redness) with warm hydrochloric acid and stannous chloride. the iron is removed and the structure, as outlined by occluded sedimentary material (such as clay or coal), may be studied.

Certain common characters are observed. (1) The spherulites occur in association with fine-grained sediments of carbonaceous, muddy, or silty type, often with comminuted plant-tissue; (2) the deposits seem, without exception, to be of freshwater origin and devoid of calcareous shelly remains; (3) the carbonate material in most cases consists of nearly pure siderite, with a little carbonate of magnesium and calcium (usually in dolomite-proportions); (4) the spherulites are fairly uniform in size locally: the smallest series has a diameter of about 0.5 mm., and the largest series 2 to 3 mm.; (5)the occluded sediment is similar to that in which the spherulites are embedded, and (6) where "zoning" of the sediment occurs, it is subordinate to radial structure.

It is concluded that the spherulites have formed from iron-carbonate solutions held within the gradually settling and consolidating sediment. The contrast in the character of carbonate chemically precipitated from solution (as in the blackband and clay-ironstones) is noted.

The reactions resulting from the presence in sediments of humate compounds, salt, calcium carbonate, etc., are considered. The author believes that the iron compounds present in solution in fresh water as carbonates, humates, or hydrolized and possibly colloidal hydrates, were adsorbed by the fine-grained and partly colloidal sediments and were carried down with them during deposition. Conditions of supersaturation would result from the settling and flocculation of the sediment, and from the gradual upward expulsion of the more readily diffused water-molecules. Crystallisation would then commence at a number of centres simultaneously, the spherulitic growth ceasing before the consolidation of the sediment was completed. Comparisons are instituted with well-known diffusion the production of "zoning."

Interfering surfaces between adjoining sprerulites are mostly plane, but occasionally are slightly concave to the smaller individuals.

NOTICES OF BOOKS.

A Pronouncing Chemical Formula Speller and Context Guide, by C. ALFRED JACOBSON, professor of Chemistry, West Virginia University. Price 20s. net. London agents: Baillière Tindall and Cox, 8, Henrietta Street, Covent Garden, W.C.2.

This is a well-prepared and carefully edited work of 279 + XVIII pp, demy 8vo., which deserves a good patronage from not only students, but all interested in chemical and general scientific matters. It might be called a formulæ dictionary, which will prove useful for ready reference on various chemical and kindred matters. After the introduction, which includes nomenclature and key to pronounciation, there is given a list of inorganic and organic chemical compounds, a list of minerals, atomic weights of the elements, and typical chemical reactions, and a list of typical reactions in alphabetical order from aluminium to zirconium. There are given 2,850 names of inorganic compounds, 1,000 formulæ, as wel las some 800 minerals and 1,554 questions and answers.

Organic Derivatives of Antimony, by

WALTER G. CHRISTIANSEN (Instructor of the Harvard Medical School).

This work of 280 pages is one of the well-known monograph series of the American Chemical Society, which is issued by the Chemical Catalogue Company, 19, East 24th Street, N.Y., U.S.A. As explained in the preface, the objects of these monographs (fully realised in those already issued) are (1) to present the knowledge available on any given subject, in a readable form, intelligible to scientists whose activities lie along wholly different lines, and () to promote research in the branch of science covered by the monograph.

As is very frequently the case in scientific works, there is not the slightest indication as far as we can see at a hasty glance, as to the price of the book. We think this method is a mistake, and is certainly a nuisance to representatives of publishers, who are day after day calling on booksellers to collect the various works ordered by customers.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

18,255.—Branwell, F. H. Catalytic apparatus for synthesis of ammonia. July 17th.

17,992.—Chmura, T.—Utilising by-products and heat produced by combustion of incompletely-oxidised sulphur compounds. July 14th.

18,027.—Coke and Gas Ovens, Ltd.—Neutralising free acid in sulphate of ammonia. July 14th.

18,205.—Gladitz, C.—Process of forming chemical compounds, etc. July 16th.

Specifications Published this Week. ...

236,256.—Millar, W. S.—Desulphurisation and concentration of sulphide iron ores.

236,336.—Cross, C. F., and Viscose Development Co., Ltd.—Application of cellulose hydrates.

236,379.—Burdick, J. N.—Process of making olefine oxides.

221,513.—Synthetic Ammonia & Nitrates, Ltd.—Production of nitric acid from ammonia.

Abstract Published this Week.

234,677.—Synthetic drugs. — Wellcome Foundation, Ltd., 67, Holborn Viaduct, and Gray, W. H., 6, Snow Hill, both in London.

A glucose of sodium *p*-aminophenylstibinate is prepared by the interaction of glucose and sodium p-aminophenylstibinate in aqueous solution in the presence of excess of alkali and for a prolonged period. The product is useful in the treatment of tropical diseases. An example is given.

Messrs. Rayner and Co., will obtain printed copies of the Published Specifications only, and forward on post free for the price of 1/6 each.

The Latest TRADE MARKS

The following list of latest Trade Marks Published, is specially prepared for "*The Chemical News*," by Messrs. Rayner and Co., Regd. Patent and Trade Mark Agents, of 5, Chancery Lane, London, who will give all information free regarding the Registration of British and Foreign Trade Marks.

CAAPI BRAND.

458,919.—Chemical Substances prepared for use in Medicine and Pharmacy.—H. R. Napp, Ltd., 3 and 4, Clement's Inn, Kingsway, London, W.C. July 22nd, 1925.

TROYAL.

459,065.—Chemical Substances prepared for

use in Medicine and Pharmacy.—John Taylor, 19, Ropergate, Pontefract. July 22nd, 1925.

BOROCAINE.

459,625.—Chemical Substances prepared for use in Medicine and Pharmacy.—The British Drug Houses, Ltd., 22 to 30, Graham Street, City Road, London, N.1. July 22nd, 1925.

ASKARIDOL.

459,309.—Chemical Substances used for Agricultural, Horticultural, Veterinary and Sanitary Purposes.—Crown Chemical Co., Ltd., 52, Crutched Friars, London, E.C.3. July 22nd, 1925 .

The above Marks have been "accepted" by H.M. Patent Office, and unless any objection is lodged, the Marks will be duly Registered. They are, however, officially advertised for opposition, which must be lodged within one month from date quoted. All particulars and forms for opposition will be sent free by Messrs. Rayner and Co., 5, Chancery Lane, London.

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CRITICAL STUDIES ON METHODS OF ANALYSIS. XVI.—ZINC.

By LEON A. CONGDON, A. B. GUSS, AND F. A WINTER.

(Contribution from the Department of Chemistry, Syracuse University)

INTRODUCTION.

(*Continued from Page 84.*)

I. M. Kolthoff and J. C. Van Dijk (95) state that the KCN method for zinc is less satisfactory than Jamieson's (85) volumetric $K_2Hg(SCN)_4$ method which they state gives excellent results in absence of Cl, and SO_4. Also they state that NO_3 does not interfere with Jamieson's process, and when the zinc concentration is above 0.01 normal the solution may be filtered immediately after adding the NH_4SCN, $HgCl_2$ reagent. When the solution is less than 0.01 normal, the solution should stand one day before filtering. The excess of the reagent in the filtrate, which they titrate back by the Volhard method, must not be less than 0.06 normal.

(n) *Miscellaneous Methods.*—Among other methods for the estimation of zinc may be mentioned Turbidimetric, Colorimetric, and Indirect Gasometric methods. Turbidimetric methods are generally used for approximating small amounts of zinc. V. Berkner (99) has worked out such a method in estimating the zinc content of some foodstuffs. H. L. Lourie (100) reports two methods for determining zinc in egg products. M. Bodansky (101) made a study of determining small quantities of zinc, especially the zinc content of microorganisms. A turbidimetric method was used, which was based upon previous recommendations of Beyer and of Berkner.

A. Del Campo (107) determines zinc colourimetrically in accordance with the fact that zinc gives a blue colour by resorcinol in alkaline solution. The character of the colour is altered somewhat on exposure to the air. The addition of HCl turns the solution red and this colour is not altered. Other metals do not interfere unless they have a coloured solution before the addition of the reagent—and if such is the case, the interfering metal must be removed. The sample suitable for test must contain 0.003 and 0.000005 gram of zinc. The standard used is a solution of 0.1 gram of pure zinc in HNO_3 and dilution to one litre. An aliquot suitable for comparison is taken and treated the same as the sample. The duplication method is used for comparison and should contain 70 cc. of H_2O. The test in alkaline solution which gives the blue colour should be checked by the test in acid solution which gives a red colour.

Edgar Beyer (102) devises an apparatus for the evaluation of zinc dust by the indirect gasometric method. The apparatus consists of a gas burette, a levelling bottle, and a generating flask. The burette has a 300 cc. bulb at the top and graduations from 300 cc. to 375 cc. The zero point coincides with the boring of a glass stop-cock above the bulb. The metal is dissolved in a flask and the escaping gae, *i.e.*, H_2, passes through a cooling spiral as described by de Koneck (103). L. A. Wilson (104) describes a gasometric method for the evaluation of zinc dust wherein he simplified the calculation involved by modification of the apparatus generally used. A factor is introduced to the fact that the vapour pressure over 10% H_2SO_4 is lower than pure water.

T. K. Rose (105) has revived an old method for the determination of zinc in coinage bronze, which was supposed to have been discredited half a century ago. It has been used at the Royal Mint and shown to be as accurate as other available processes. The method consists in volatil-

izing the zinc, while protecting the metal against oxidation. The use of proof assays is necessary, as is a high temperature (1375°) which temperature was not available at the time the method fell into disuse.

(o) *Comparative Studies.*—A summary should be made here of the few important studies that have been made by various investigators on comparison of methods for the determination of zinc. As stated in the introduction, most of the comparative studies which have been made are for the reliability of the precipitation volumetric processes for zinc. E. Oliver (71) compared the Galletti ferrocyanide and the Schaffner sodium sulfide precipitation volumetric processes. These processes were also studied by L. L. De Konninck and E. Prost (106). J. H. Hastings (108) discusses Low's and also Waring's modifications of separating zinc for the Galletti ferrocyanide volumetric precipitation process. B. C. Hinman (62) discusses Von Schultz's and Low's methods of determining zinc, and while satisfactory for readily decomposable ores containing little or no iron, he finds that they require modification in ores containing iron, inasmuch as the iron precipitate carries zinc down with it. . C. Wilson (45) compares and discusses the volumetric $K_4Fe(CN)_6$ method with the gravimetric electrolytic method. Nissenson (41) compares the volumetric sodium sulfide and ferrocyanide processes with the gravimetric methods of zinc as sulfide and by electrolysis, obtaining equally good results. Jander and Stuhlman (80) in their study of chemical analysis with membrane filters studied the volumetric methods of Houber, Taylor, Mohr, Pouget, and Mann. Good results were obtained by dissolving the ZnS precipitate in excess of standard mineral acids, boiling off the H_2S and titrating with standard alkali hydroxide using methyl orange as an indicator. H_2SO_4 may be used as a standard acid, but 0.2 normal HCl or HBr was found to be somewhat better. In the precipitation of ZnS from solutions prepared from zinc, accurate results were obtained in test analysis when the nearly neutral solution was treated with sodium acetate and then saturated with H_2S. Such precipitates could be weighed as ZnS, after heating in hydrogen, but results were high if they were roasted to ZnO. By the use of membrane filters, a precipitate which would require 6 hours to filter and wash, could be handled in 20 minutes.

3.—Experimental.

In this critical study on methods of analysis, a sample of zinc nitrate crystals, $Zn(NO_3)_2 \cdot 6H_2O$, containing 0.001% Fe, 0.002% Cl, 0.001% SO_3, and no lead, was used. The sample was prepared for analysis by dissolving a weighed amount in water made up to certain volume, and aliquote used for each determination. The gravimetric methods for zinc experimented upon were six modifications of the phosphate method, three modifications of the sulfide method, and three modifications of the oxide method. The volumetric methods tried were three modifications of the $K_4Fe(CN)_6$ process, using different indicators, and the Percy Walker's volumetric neutralization method. The total number of methods or modifications tried was nineteen. The following table gives the results of this study :—

Method Used.	Weight Sample. Gram.	Theor. % Zn.	Amount Zn found %	Average Amount Zn found %	Diff. from Theor. %
As Phosphate—					
(a) Dakin's mod. of Tamm's, weighed as $ZnNH_4PO_4$, filtering hot after heating on water bath 1 hour	0.8054	21.97	21.85 22.01	21.93	-0.04
(b) Findlay and Cumming's Mod. of Dakin's weighed as $Zn_2P_2O_7$	0.8054	21.97	21.84 22.08	21.94	-0.03
(c) Similar to Dakin's, weighed as $ZnNH_4PO_4$. Letting stand 2.5 hours and filtering cold	0.1751	21.97	21.87 21.82	21.85	-0.12

Method Used	Weight Sample. Gram.	Theor. % Zn.	Amount Zn found %	Average Amount Zn found %	Diff. from Theor. %
(d) As above but letting stand 4 hours	0.1751	21.97	21.93 21.76	21.85	−0.12
(e) Losekam and Meyer's mod. of Tamm's method	0.1751	21.97	20.78 20.16 20.16 20.33	20.43	−1.54
(f(Mod. of above, using warm sol. of NH_4NO_3 as wash instead of water, and standing 5 hours	0.1751	21.97	21.70 21.47 21.53	21.57	−0.40
As Sulfide—					
(a) A. Guyard's by Amm. Sulfocarbonate, heated by Bunsen burner to Zns and weighed as such	4.3054	21.97	22.06 22.10	22.08	+0.11
(b) By H_2S in NH_4AC sol., drying at 100°-105° on weighted filter paper to Zns	0.1751	21.97	21.59	21.59	−0.38
(c) As above in NaAc solution	0.1751	21.97	21.64	21.64	−0.33
As Sulfate—					
(a) P'pt'd as ZnS by H_2S in NH_4Ac sol. Changed to sulfate by H_2SO_4 and weighed as $ZnSO_4$	0.1751	21.97	21.85 21.90	21.88	−0.09
(b) As above except in KAc solution	0.1751	21.97	21.95 21.97	21.96	−.01
(c) As above, except p'p't'd by $(NH_4)_2S$ in water solution	0.3054	21.97	21.73 21.81	21.77	−0.20
As Oxide—					
(a) P'p't'd as Zns by sulfur in a solution of KOH, ignited by muffle to ZnO and weighed as such	0.3054	21.97	21.78 21.84	21.81	−0.16
(b) P'p't'd as ZnS by H_2S in KAc solution, ignited to ZnO and weighed as such...	0.1751	21.97	21.59 21.69	21.64	−0.33
(c) P'p't'd as Zn $Py_2(SCN)_2$ by sulfocyanide and pyridine, and ignited to ZnO in which form it is weighed	0.1146 0.1141	21.97	21.94 21.92	21.93	−0.04

VOLUMETRIC $K_4Fe(CN)_6$ METHOD—					
(a) Using uranium nitrate as indicator	0.1777	21.97	22.01	22.07	+0.10
	0.1777		22.05		
	0.3490		22.34		
	0.3490		21.87		
(b) Using uranium acetate as indicator	0.3490	21.97	21.75	21.99	+0.02
			22.22		
(c) Using uranium chloride as indicator	0.1777	21.97	22.39	22.07	+0.10
			21.74		
PERCY WALKER'S VOLUMETRIC NEUTRALIZATION METHOD—					
By adding excess stand. acid to the $ZnNH_4PO_4$ p'p't'e and titration of excess with stand. alkali	0.1777	21.97	22.40	22.41	40.44
			22.42		

A study of the results of these experiments shows that the most concordant accurate results for the estimation of zinc were obtained by either the gravimetric sulfate method where the zinc nitrate solution was precipitated by H_2S in the presence of potassium acetate, changed to sulfate by H_2SO_4, or the gravimetric oxide method of Spacu, where the zinc nitrate solution was precipitated by ammonium sulfocyanide and pyridine to $ZnPy_2(SCN)_2$ and strongly ignited to the oxide to constant weight in which form it is weighed.

(*To be Continued.*)

METEORS.

By F. H. LORING.

It is of interest in connection with the nature or origin of meteoric bodies to consider the supposed relationship between certain comets and showers of shooting stars, as they are popularly called, which are swarms of meteors that pass into the outer atmosphere of the earth at an altitude of about 65 miles. Other matters are also of interest. These bodies are probably very small, as they appear to be completely consumed by the intense heat generated by their friction in passing swiftly into the rarefied atmosphere; but they leave luminous tails, or trains, behind them as they pass. These trains persist for a little time; even for a few minutes, or much longer in some instances (*e.g.*, 40 minutes). Usually, however, the duration is only a few seconds, or even much less to the casual observer. With the aid of a telescope, such durations as just mentioned are seen.

This seems to show that the phenomenon is due to a trail of luminous gas—a kind of phosphorescence in the gaseous atmosphere through which they glide. In fact, a long tubular luminous cloud appears often to be formed, but it soon vanishes.

A number of spectroscopic observations have been made. It is necessary to distinguish between the spectrum of the train and that of the meteor proper, or the nucleus, as it is termed. A recent summary of this work is given by Miss Mabel Weil (who worked with the late Prof. C. C. Trowbridge), in the *Proceedings of the National Academy of Sciences*, U.S.A., January, 1924, p. 24 (*see* abstract in *Chemical News*, 1924, CXXVIII., p. 122), attention being drawn to the phenomenon of afterglow in gases as being the cause of the luminous meteoric trains; in fact, it is probable that the observed meterological phenomenon is mainly an afterglow effect.

Spectroscopic investigations of the afterglow of nitrogen by Strutt (now the succeeding Lord Rayleigh) and Fowler, point to this similarity, as may be judged from the accompanying table (I.) taken from the article above mentioned. The afterglow of nitrogen had been previously studied by E. P. Lewis in 1900 and C. C. Trowbridge in 1906.

Table I.

Nitrogen Afterglow Spectrum Lines.	Meteor-train Spectrum by Blajko Lines.
3572.9	3578.
3584.7	3802.9
3789.3	4027.0
3801.9	4042.5
4028.7	4066.0
4042.8	

It is of interest here to note the composition of the atmosphere at different heights. C. P. Oliver in his book "Meteors," 1925, p. 125, gives a table showing the distribution of the gases of the atmosphere (exclusive of the small quantities of neon, krypton and xenon), as given by W. J. Humphreys in his " Physics of the Air." This table is here reproduced with the minor change of omitting some of the decimal-place figures, and rounding off some of the values, as it is not assumed that they are very accurate, those above 85 kms. being extrapolated. The horizontal summations are approximately 100.

Table II.

HEIGHT	ARGON	NITROGEN	WATER V	OXYGEN	C DIOXIDE	HYDROGEN	HELIUM	PRESSURE
KM								MM
140		0 10				99	0·56	0 0040
130		·04				99	·41	0096
120		·2				99	·46	0052
110		·7	0 02	0·02		99·	·51	0059
100		3·	05	·11		96	·56	0067
90		10	·10	·5		89·	58	0081
80		32·	·17	2·		65	47	0123
70	0.03	52·	20	5		33	26	0274
60	.03	81	15	8·		11	10	0935
50	·1	87·	·10	10·		2 8	03	·403
40	2	86	·06	13		0 67	01	1·84
30	·4	84	·03	15	0 01	·16		8·63
20	6	81·	02	18	01	·04		41·
15	8	79	·01	20	02	02		90
11	9	78	01	21	03	·01		168
5	9	78·	2	21	03	.01		405
0	9	77	1·2	21	03	.01		760

This table involves several assumptions, *viz.* :—(1) that the atmospheric gases, in percentages by volume, in dry air at the surface of the earth are :—N_2 78.03; O_2 20.99; Ar 0.94; H_2 0.01; Ne 0.0015; He 0.00015; CO_2 0.03; (2) that water vapour amounts to 1.2 per cent. at the lowest level; and (3) that it decreases at lower temperatures with increase of elevation to a negligibly small amount at or just below 10 kms; (4) that the temperature decreases at the average rate of 6° C. per km. from 11° C. at sea-level to − 55° C. at an elevation of 11 kms; (5) that beyond 11 kms above sea level the temperature remains constant at − 55° C.; (6) that up to the level of 11 kms. the relative percentages of the several gases, excepting water vapour, remain constant as a result of vertical convection; (7) that above 11 kms. where the temperature gradient is slight, and the vertical convection negligible, the several gases are distributed according to their molecular weights. Middle latitudes are assumed also.

From this table it will be evident that nitrogen at low pressure should be present in appreciable relative quantity at the elevation at which the trains occur, and this agrees in general with experiment.

Meteoric showers appear to radiate from a given point or small area indicated by the constellation in the field of observation, the radial appearance being due to perspective (vanishing point) for the meteors really enter the earth's atmosphere in a common direction, the paths being sensibly parallel to one another in each shower.

Making a general survey, using some figures given by Denning, meteors are seldom seen above 130 miles, but a case of 216 miles appears to be recorded. It has been stated that meteors generally appear at an altitude of 76 miles (122 kms.) and disappear at 51 miles (82 kms.).

Passing now to the comet side of the problem, apart from the nightly occurrence of shooting stars, there are periodic swarms of meteoric bodies which have been found to be connected with certain comets, apparently exclusively, as shown by Table III., taken from Jones' " General Astronomy," 1922, p. 281.

Table III.

CONSTELLATION RADIANT.	METEOR SHOWER.	DATE.	COMET.	PERIOD IN YEARS
LYRA	LYRIDS	APRIL 20-21	1861 I	415
PERSEUS	PERSEIDS	AUG 10-11	1862 III	120
LEO	LEONIDS	NOV. 14-15	1866 I	$33\frac{1}{3}$
ANDROMEDA	BIELIDS	NOV. 23	BIELA	$6\frac{3}{4}$

The precise connection between these comets and the meteoric showers is better shown from the following tables, as given in Oliver's book cited above. No other comprehensive tables of this particular kind are given. The elements of these tables need not be elucidated here, as the corresponding values are quoted merely to show numerical similarity in support of the argument presented, for it has been stated that there are only *four* meteoric swarms (here given) connected with comets, about which there can be no adverse contention.

Table IV.

Radiant Date....	217°.5+34°.6 April 20	Comet 1861 I.	260°.0+33°.5 April 18	267°.0+33°.0 April 19.	274°.0+35°.5 April 20.
Longitude of p.p.	236°	243° 42′	255° 42′	248° 54′	240° 34′
Longitude of a.n.	30	30 16	29 05	30 04	31 03
Incl'n to plane of e	89	79 46	71 20	77 29	81 29
Perihelion distance	0·955	0 9270	0·8478	0·8944	0 9270
Log semi-maj. axis	1·746	1·746			
Eccentricity	0 9829	0 9835			
Relative velocity		30 m. per s	28 m per s	29 m per s	30 m per s

In the above table, p.p. = perihelion point; a.n. = ascending node; e = ecliptic; m = miles; s = seconds. It will be seen that the agreement between the elements of the comet, and those of the Lyrids on each side is exceedingly good. The following tables should be noted.

Table V.

	Perseids, 1866.	Comet 1862 III.
Perihelion passage...	July 23·62	Aug. 22·9, 1862
Node............	Aug. 10·75	
Longitude of perihelion.	343° 48′	344° 41′
Longitude of node....	138 16	137 27
Inclination........	115 57	113 34
Perihelion distance..	0·9643	0·9626

Table VI.

	Leonids	Comet 1866 I.
Perihelion passage...	Nov. 10·092	Jan. 11·160
Longitude of perihelion.	56° 25′·9	60° 28′·0
Ascending node....	231 28·2	231 26·1
Inclination........	162 15·5	162 41·9
Perihelion distance..	0·9873	0·9765
Eccentricity......	0·9046	0·9054
Semi-major axis....	10·34	10.344
Period in years.....	33·25	33.176

The relative velocity of the Leonids is given as about 44 miles per second, this being high because the earth meets them.

Table VII.

	Andromedes Nov. 27.	Biela's Comet.
Pos. of apparent radiant..	$\alpha = 23°\!.7$ $\delta = +44°\!.3$	$\alpha = 24°\!.0$ $\delta = +45°\!.2$
Pos. of true radiant...	= 352 0 = + 9·3	= 349·9 = +7·7
Longitude of perihelion.	108° 16′	109° 40′
Longitude of node...	245 57	246 29
Inclination......	13 08	12 33
Perihelion distance..	0·8578	0·8606
Relative velocity...	12 miles per sec	12 miles per sec

As will be observed from these tables, certain meteoric showers appear to be definitely associated with certain comets that describe orbits forming a part of the solar system considered as an island universe in the vast ocean of space. Using the term " island universe," leads to a digression here.

The nearest star to this "universe" is Proxima Centauri, which is 24 million million (24×10^{12}) miles distant. There is another star, α Centauri, at 25 million million miles from the solar system. The known periodic comets are regarded as proper members of the solar system as, apart from other obvious considerations, the largest orbits at aphelion are enormously distant from the nearest star. The isolation of the solar system is of interest.

To complete this part of the article, a paragraph from Heath's " Popular Astronomy," 3rd edition, p. 109, will be presented here :—" From many of the known radiants, showers reappear year after year at the same date, showing that the meteors are spread along the entire length of the orbit with some degree of uniformity. Such is the case with the August meteors, the Perseids. Every year, when the earth reaches the point of intersection of its orbit with the Perseid orbit, on 10th August, we encounter a number of these meteors, resulting in a shower of greater or less persistence. A number of Perseids are also to be seen a few days before and after this date ,owing to the meteors not being collected into a thin stream in the immediate neighbourhood of the linear or theoretical orbit, but spread out for hundreds of miles on each side of it. The Leonids, on the other hand, appear as conspicuous showers only at intervals of several years, though a few members of the swarm are to be seen every year at the date of the shower ,14th November. From this it is evident that the Leonid meteors are thickly congregated along a part of their orbit only, the rest of the orbit being just sparsely populated. The crowded portion is probably long enough to occupy two or three years in passing any particular point of the orbit. The shower may, therefore, recur two or three years in succession, after which it will not be conspicuous for thirty-three or thirty-four years, thirty-three and a quarter years being the periodic time of the meteors. Their orbit is a very eccentric one, reaching out beyond the orbit of Uranus."

There are other meteoric showers than those given in this survey, but they are not so well associated with other comets.

Referring now to Tables III. to VI., and to the B numbers developed by the present writer in connection with planetary and atomic phenomena, a rule is here given which serves to co-ordinate the periods in respect of the comets, or rather the meteoric showers associated with them. This rule must be regarded as fortuitous, and the agreements as accidental, because (1) the grouping of the B numbers is arbitrary, and (2) the periods of the meteoric showers are not all accurately enough established to test any rule of this kind. It, however, serves to fix in mind the unique set of showers which are so well connected with the comets in question. (See also Table III.)

Table VIII.

B NUMBERS.	B NOS. × 1·0075	PERIODS.
412*	415 07	415
119	119·89	120
45 }	33·247	33·25
21 }		
13 }		
9 }		
7 }	6·73	6·729
3 }		
1·4 }		

* VALUES DERIVED FROM SATELLITE DISTANCES INDICATE THAT THE HARMONIC MEAN BETWEEN EXTREME VALUES IS .... 409·7

THE ARITHMETICAL MEAN BETWEEN GROUP VALUES .. 413·8

THE HARMONIC MEAN BETWEEN GROUP VALUES IS 412·5

GRAND MEAN .. 412·0

Referring now to Tables III. to VIII. and "group values" will be understood by working out the satellite B Nos. Not knowing in this particular case what value to take, and assuming that a mean would reduce the possible error, a "grand mean" was taken. *Exact agreements are not, of course, significant.*

It should be explained here that the B numbers are derivable from planetary and satellite distances as worked out by the present writer, but they are more accurately formulated by the following method (also by the present writer) involving the atomic number of the inert gases thus :—

Table IX.

B NO SERIES		AT NO	INERT GAS
$(3\times1)-1^2$	=	2	He
$(7\times2)-2^2$	=	10	Ne
$(9\times3)-3^2$	=	18	Ar
$(13\times4)-4^2$	=	36	Kr
$(21\times3)-3^2$	=	54	Xe
$(45\times2)-2^2$	=	86	Rn
$(119\times1)-1^2$	=	118	

USING THE WELL-KNOWN SERIES FOR CALCULATING THE ATOMIC NUMBERS OF THE INERT GASES AND COMBINING WITH IT THE SERIES $n = 1, 2, 3, 4, 3, 2, 1$, THEN BY STOPPING OFF TERMS THE B NUMBERS CAN BE CALCULATED THUS—

$$\frac{\left[2\times(1^2+2^2+2^2+3^2+3^2+4^2+4^2)\right]+n^2}{n} = \text{B Nos.}$$

THEREFORE $Bn - n^2 = \text{At. No.}$

The value 1.4 was found necessary in extending the B numbers to co-ordinate other phenomena by these numbers, while the value 412 became necessary on account of the most distant satellites, barring two which involve a much higher number still (about 795).

Returning to the subject of meteors or meteorites, the latter being a kindred phenomenon, with one or two exceptions no known meteorite has fallen to earth as coming from a meteoric shower. In one case, though it may only be apparent, the Mazapil meteorite (8864 grams) fell on November 27, 1885, near to Mazapil, Mexico, during the shower of Andromedes (Bielids), its composition being largely iron. This event may have been a chance coincidence, but some regard this meteorite as being a fragment of Biela's comet. An "iron" meteorite fell in England on April 20, 1876, but otherwise no "falls" were recorded at the dates of the Lyrids.

Meteors are, therefore, small bodies which are apparently consumed in the upper atmosphere as already mentioned. Those bodies which reach the earth of a size sufficient to be recognised (in transit or recovered), are, as is well known, termed *meteorites*.

The masses of these found bodies vary from tiny fragments to 36½ tons, or even much larger in one recently reported case in the London *Times*. Taking the approximate number of meteorites found, and whether "iron" or "stone" specimens, the rough ratio stands, respectively, 261 to

378, not taking into account many thousands of fragments. Figures of this kind are, obviously, only rough evaluations.

There is no reason to suppose that the shooting stars are necessarily composed of the same chemical elements as found in meteorites. It may be noted that Blajko observed a meteor, August 12, 1904, which gave, amongst other spectrum lines, one closely agreeing with a thallium line, 3774.1 as compared with Tl 3775.9.

The composition of meteors ,as revealed by the spectrum associated with the nucleus, does not appear to be sufficiently studied to afford much reliable information.

The composition of meteorites has been the subject of much investigation. As an example, a set of analyses is detailed in Roscoe and Schorlemmer's "Treatise on Chemistry," Vol. II. A book on meteorites by O. C. Farrington, was published in 1915, but it is not made use of in this study.

In preparing this article, the writer has made free use of some of the material given in the citations above, and to which may be added a few articles by him in the *Chemical News*, 1923-24.

(Notes to follow next week.)

(*To be Continued.*)

General Notes.

FIRST INTERNATIONAL CONFERENCE OF THE TECHNICAL PRESS.

From October 1st to October 4th a conference organised by the technical, industrial, and commercial Press of France is due to be held at the Hotel du Cercle de la Libraire, Paris, Boulevard Saint Germain. The Committee is a representative one and the congress promises to be both interesting and useful.

EXPECT TWENTY COLLEGES AT CHEMICAL EXPOSITION.

About twenty leading American colleges and universities have filed applications for their students of chemistry and chemical engineering to take the one-week course of intensive training in practical technique of chemical engineering to be held in conjunction with the Tenth Exposition of Chemical Industries at the Grand Central Palace, New York, during the week of September 28 to October 3. More than three hundred students are expected to enrol before the closing date. All students of recognised colleges, as well as practicing chemical engineers, who desire to brush up on fundamentals, are eligible to take the course, which is without cost.

MANUFACTURE OF STEEL AND IRON IN SWEDEN.

The Journal of the Chemical, Metallurgical, and Mining Society of South Africa for May contains an interesting account of the above subject by L. Nordenfelt.

Iron was made in Sweden and fairly generally used about 500 years B.C. The only ore used was for a very long time alluvial hæmatite collected in the form of mud from mires and the bottoms of lakes. The product was not pig but soft iron called osmund iron. Real mining of iron ore is known about the year 1300, and has probably taken place earlier. About 1450 pig iron was manufactured, and from this time we can consider that a real industry has existed.

SPIRITS AND BRANDIES.

An interesting paper on the comparative results of the analyses of spirits and brandies which was read before the Cape Chemical Society on 22 August, 1924, by F. Fevrier, B.A., Assistant Viticulturist, has been reprinted by the (Government) Division of Chemistry, Pretoria (Chemistry Series No. 55.)

THE BRITISH CHEMICAL PLANT MANUFACTURERS' ASSOCIATION.

The British Chemical Plant Manufacturers' Association held its fifth annual general meeting at 166, Piccadilly, W.1., on Wednesday, July 22, 1925, when the report of the Committee was unanimously adopted.

The Committee has commenced active propaganda with a view to bringing before chemical manufacturers the desirability of utilising British plant. With the concurrence of the Organising Committee of the London Meeting of the Society of Chemical Industry in July, 1926, an exhibition of chemical plant is being arranged, and a subcommittee consisting of Dr. R. Seligman, Mr. . A. Reavell, Mr. E. A. Alliott and Mr. W. J. U. Woolcock has been appointed to prepare the plans.

The following officers were elected for 1925-26 :—

Chairman—Dr. R. Seligman.
Vice-Chairman—Mr. J. A. Reavell.
Honorary Treasurer—Mr. E. A. Alliott.

During the evening a successful dinner was held at the Holborn Restaurant. The guests of the Association were Mr. F. H. Carr, Mr. J. V. N. Dorr, Mr. E. V. Evans, and Mr. R. L. Mond. The speeches were characterised by a call for greater sympathy between British plant manufacturers and their clients, the chemical manufacturers. A number of the speakers referred to methods adopted by continental competitors and emphasis was laid on the necessity for the plant manufacturers to understand the processes which were to be carried out. Mr. Dorr, in particular, referred to the successful results which had attended the holding of chemical exposition in New York, and wished prosperity to the Association's plans for next summer.

NEW ZINC REFINERY TO OPERATE IN CANADA.

The large new zinc refinery of the Consolidated Mining and Smelting Company, Limited, which has been under construction for some months, is expected to commence operations early in August. This will mean that the export of refined zinc from the Company's plant in the interior of the province will be materially increased, and, unless the demand for zinc grows rapidly, shopments of concentrates will be replaced in time by refined metal. Expirts of lead and zinc last year were about two-thirds greater than in 1923. The Orient and the Unitel Kingdom are expected to take the entire output of the new refinery.

PROCEEDINGS AND NOTICES OF SOCIETIES.

PHYSICAL SOCIETY OF LONDON.

Proceedings at the Meeting held on June 12, 1925, at the Imperial College of Science.

F. E. Smith, C.B.E., F.R.S., President, in the chair.

A paper *On Mass and Energy* was read by G. Temple, Ph.D., Imperial College of Science.

ABSTRACT.

It is assumed that variations in the potential energy of a body (gravitational or electrostatic) are always accompanied by proportionate changes in its mass. Continuing this assumption with the theories of Newtonian dynamics and Maxwellian electrodynamics, it has been found possible to predict all those phenomena, which are usually regarded as the crucial tests of the theories of relativity, both "special" and "general."

DISCUSSION.

Prof. A. S. Eddington (communicated): I have had the opportunity of reading Dr. Temple's paper. I have no quarrel with his mathematics, and have often admired the elegance and ingenuity of his methods. But it seems to me that work of this kind can only appeal to someone who has already been led to believe that the relativity theory is fallacious. Otherwise I cannot imagine why anyone should reject the complete physical theory of Einstein, and prefer the method proposed by Dr. Temple (and others) of an arbitrary tinkering of the fundamental equations. It seems to me that Einstein's method, which consists in rejecting certain hypotheses which had crept into current physics without any experimental support, and re-examining our knowledge unbiased by these traditional hypotheses, goes deeper and is more convincing than any proposal to patch up the Newtonian equations by addition of extra terms.

I do not think that the success in explaining "crucial" phenomena is greater than would be expected from the additional constants introduced. It would be interesting if a term added to explain change of mass with velocity were found also to explain the gravitational deflection of light. But it does not. It gives only half the observed deflection; and the discrepancy has to be cured by arbitrarily doubling the terms. The displacement of the Fraunhofer lines is not explained; Dr. Temple tackles it by a procedure justified if the relativity theory is accepted, but admittedly unjustified on his own theory, and obtains a result which the experimental evidence (such as it is) does not seem to favour. The fine structure of the hydrogen lines is scarcely an *additional* success; the discussion of this phenomenon was required in order to remove an apparent difficulty in Dr. Temple's theory which does not arise in Lorentz's or Einstein's theory. I think the one distinct success is in deriving the perihelion of mercury and the deflection of light from the same formulation of the equations; but even here it seems that we

are required to accept a conclusion of the relativity theory (whilst rejecting the arguments that led to it. Surely the discovery that gravitation acts on light-waves compels us to reject the Newtonian picture of gravitation as a force—you cannot deflect *waves* by tugging at them; Newton's picture of the invisible agent that pulls down the apple does not correspond to an agency which can deviate a train of waves. We have to find (as Einstein has done) a new picture of the gravitational field which shall represent its action on waves as well as on particles; and it is this new picture which gives us the hint as to the natural formulation of the law of gravitation.

Dr. D. Owen said that the author had set out to provide a theory more congenial to experimental physicists than Einstein's, but though the hands were the hands of Esau the voice was Jacob's voice. The theory put forward appeared to him identical in principle with Einstein's theory, though expressed in another form. He would like to ask the author whether his theory left any room for the ether? Apparently it did not, and although some physicists had dispensed with the ether without discomfort, others felt that its loss had left a blank. Then the fundamental equation (2.1) of the paper is simply a form of that Einstein result which identifies enerby with mass, a result that is bound up with the implications of Einstein's theory. In equation (2.7) the author introduces a "proper time" T, but if the physicist cannot have his absolute time he is not much better off with one sort of proper time than he is with another. In dealing with the shift of the Fraunhöfer lines the author speaks rather contemptuously of the "naïve procedure" of assuming a certain behaviour of "atomic clocks," but apparently he makes a very similar assumption himself. It is true that he arrives at a shift of different numerical value from that deduced by Einstein, but there is no great difference in principle. The theory contains another weak spot in the fact that the factor λ has different values for gravitational and electrical fields. The mathematical skill displayed in the paper, however, was of an order to excite the admiration of the most hardened of experimental physicists.

Capt. C. W. Hume (communicated subsequently): The metaphysical significance of the paper seems to lie in the fact that it further delivers us from those strange paradoxes concerning the nature of space and time with which Einstein has troubled our peace. To anyone who holds the idealist view of the universe a dispute as to the reality of the ether is a dispute about words, for ether and matter are in any case mere intellectual fictions which (like the virtual image in optics) serve to co-ordinate the elements of our experience. But when we are asked by Minkowski's famous dictum to believe that space and time are in some way identical in their nature, that is a very different matter. It has happened before now, as in the case of Carnot's theorem, that the mathematical structure of a theory has had to be separated from the metaphysical content in association with which it was first put forward: it is possible for the former to be true while the latter is false. The author has shown that the mathematical structure of Einstein's theory can be retained in essentials while an entirely different metaphysic, his or another, is associated with it. May I also evnture to suggest that Minkowski's dictum about the identity of time and space is based on a fallacy which arises from taking in a literal sense the loose statement that the time-space systems of two relatively moving *observers* will be different from one another. As a matter of fact, the nature of the universe is precisely the same for all observers, even on the principle of relativity; the orientation of the time-space axes is different for different *systems of measurement*, but any observer can choose any system of measurement he pleases. In the loose phraseology commonly employed, each observer is presumed to use that particular system of measurement which in practice it would be most convenient for him to use; but there is no reason in principle why he should not measure time by a flying clock and measure space with high-speed measuring rods, if he chooses. In connection with the metaphysics of relatiity it is worth noting that the time order of events in the experience of any one monad is the same "for all observers" or, rather, whatever space-time- co-ordinates you adopt, the experiences of any monad will occur in the same order, and this order is the only thing in common between clock measurements and our consciousness of time. And, secondly, any statement which contradicts our immediate intuitive judgments must be fallacious, because the statement itself must at best rest ultimately on intuitive judgments which themselves have

no greater authority than these. Now if there is any intuitive judgment that is clear and certain, it is this, that time and space are two entirely different conceptions, having nothing in common except a remote analogy between order in space and order in time. Hence, if any theory contradicts this fact, either that theory is untrue, or it involves an antinomy in the very nature of thought.

AUTHOR'S REPLY.—The very kind criticism of this paper which I have received from Professor Eddington encourages me to point out an aspect of the subject which appears to have escaped notice. I would be the last to deny the cogency of the observations which Professor Eddington has made, but I have the uneasy feeling that they tell equally against relativistic theories. Thus, though Einstein's work is spoken of as a "complete physical theory," based on the rejection of certain unverified hypotheses, a perusal of such a work as Professor Whitehead's "Principle of Relativity," with its four sets of gravitational equations, shows that there is an arbitrary element in the selection of the Einstenian gravitational equation $G_{mr}=0$; while the methods adopted by all relativists in reformulating the equations of the electromagnetic field are frankly selected in order to obtain Maxwell's equations as a first approximation. Such a procedure may not unjustly be described as "tinkering with the fundamental equations." Again, arbitrary constants and even, *horresco referens*, arbitrary functions are not entirely unknown in the General Theory of Relativity. Thus Cambridge (*Phil. Mag.* Vol. 45, pp. 726-732) has shown that the direct integration of the Einsteinian equations for a field possessing spherica lsymmetry leads to the result (for the line-element of the dynamical manifold)—

$$ds^2 = c^2\left(1-\frac{f}{a}\right)dt^2-\left(1-\frac{a}{f}\right)^{-1}\left(\frac{df}{dr}\right)^2 dr^2-f^2(d\theta^2+\sin^2\theta\,.\,d\phi^2),$$

where a is an arbitrary constant, conveniently identified with $2\,M/c^2$ (where γ = the constant of gravitation, c = velocity of light in vacuo, and M = mass of central attracting mass), and f is any arbitrary function of r, the radius vector (satisfying two boundary conditions), usually conveniently identified with r itself. There is necessarily an element of contingence in the fundamental equations of any dynamical theory, and all that the present theory can claim is a certain simplicity and intelligibility in its formulation, and a certain agreement with experience in its conclusions. In reply to Dr. Owen, I wish to emphasise the fact that although there is a certain similarity in form between the methods of the present paper and Einstein's theories, there is a radical diversity of principle. Thus, although equation (2.7) introduces a new variable "τ," named, perhaps somewhat unfortunately, "the proper time," I have deliberately refrained from attaching to this variable any physical significance, such as Minkowski would have attached to the variable bearing the same name in his interpretation of the Special Theory of Relativity; and I have explicitly stated that the one purpose served by the introduction of this variable is the expression of the equations of motion in Newtonian form—a matter of mathematical convenience rather than of metaphysical necessity. Again, the "identification of mass and energy" in Einstein's theory, alluded to by the same speaker, is a loose, if useful, contraction of a deduction from the Special Theory of Relativity, more accurately expressed in the statement that a flux of kinetic energy w with velocity v is accompanied by a momentum $g = w.v/c^2$ (*see* Chapter XIII., "The Principle of Relativity," E. Cunningham, Camb. Univ. Press, 1914). The deduction assumes that the group of transformations admitted by the equations of particle dynamics is isomorphic with the Lorentz transformation. The assumption of the present paper is distinct from this result of Einstein's, both in origin and in expression, for it does not presuppose or imply the Lorentz transformation, neither does it contain any reference to kinetic energy. Finally, it appears that both Dr. Owen and Dr. Thomas confuse the special and general theories of relativity. The assumption of that particular consequence of the special theory of relativity, to which allusion has just been made, cannot be used to predict the phenomenon of §3, neither by itself, nor when supported by the supplementary hypotheses of Poincaré (pp. 178-180, (*loc. cit.*), or of Silberstein (*Phil. Mag.* Vol. 36, pp. 94-128). The advance of the perihelion of mercury has been explained on relativistic principles, only by

the general theories o fEinstein and Whitehead, the assumptions of which are destructive of the presuppositions of the present paper regarding the independence of space and time.

The method of §5 was intended as a *reductio ad absurdum* of the method used in Einstein's theory for predicting the solar spectral shift, and like that method involves an additional *ad hoc* assumption for which no theoretical reason is given, and leads to a result not confirmed by experiment. This criticism is basen on the work of Whitehead ("The Principle of Relativity," Camb. Univ. Press. 1922, Chaps. VIII. and XIII.-XV.), who points out that, since electromagnetic forces will be affected by the gravitational field, some knowledge of molecular structure is required for an investigation of the spectral shift.

The theory outlined above implies the negation of an æther only in so far as the existence of an ether is incompatible with the Quantum Theory used in §7. The necessity for using different values in λ in gravitational and electromagnetic problems undoubtedly mars the elegance of the theory.

In reply to Mr. Calthrop, it appears from pp.151-3 of Cunningham's textbook quoted above, that although Kaufmann was himself originally of the impression that his experiments supported Abraham's formula, a recalculation of his work, based on a more accurate value of e/mv, favours the formula of Lorentz.

INSTITUTE OF METALS.

The programme of the annual autumn meeting of the Institute of Metals, which has just been issued, is an attractive one. To be held in Glasgow, the meeting begins on September 1, with a lecture by Sir John Dewrance, K.B.E., on "Education, Research, and Standardisation." The mornings of September 2 and 3 will be devoted to the reading and discussion of no fewer than sixteen papers dealing with many differing aspects of metallurgical work. In the afternoons, visits will be paid to works in the Glasgow district, and in the evening of September 2, a reception is to be given by the Lord Provost and Corporation of Glasgow. The concluding day of the meeting, September 4, is set apart for a visit to the Trossachs and Loch Lomond. A copy of the programme, giving full details of the arrangements and of a membership election to be completed in time for the meeting, can be obtained on application to the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

The monthly Council meeting was held at 16, Bedford Square, London, W.C.1., the President, Sir Gilbert Grenfell, Bart., C.V.O,. in the chair.

Mr. Luddington reported that the Committee desired to put on record their sense of the deep loss which they had sustained in the death of their former chairman, Sir J. B. Bowen-Jones, Bart. A member of the Chemical and Woburn Committee since 1875, Sir Bowen became its chairman in 1901, and distinguished himself by the great interest he had taken in the chemical, experimental and educational work of the Society, Dr. Voelcker had attended the funeral as representing the Committee. The Committee also recorded with regret the passing of Mr. C. Howard Taylor, who had been one of their number since 1918.

Dr. Voelcker had submitted a list of the samples analysed by him for members during the months of June and July.

The Chairman had reported on the action which had been taken with regard to the Fertilisers and Feeding Stuffs Act as the result of the meetings of the Advisory Committee, the last two meetings of which he had attended. Dr. Voelcker had similarly reported what had been done with regard to the revision of the Tables of Unexhausted Manures.

Dr. Voelcker had brought forward further particulars which had transpired in the cases already mentionel in the report which had been passed in May last by this Committee for insertion in the next issue of *Occasional Notes*. These particulars, together with another case relating to the poisoning of cattle by cake containing castor oil bean, had already been added to the material for the next issue.

FRENCH TRADE IN FIRST HALF-YEAR.

Imports into France during the first six months of the year were nearly a thousand million francs less in value than in the cor-from the country were close upon 400 million francs higher.

NOTICES OF BOOKS.

The Plant Physiology Laboratory of the Prague University has published, under the distinguished editorship of Prof. B. Nemec, Vol. II. (1924) of the *Studies in Plant Physiology*, pp. 106 + 5 plates.

The contents include a long paper in English by W. S. Iljin, entitled, " The Influence of Salts on the Alternation of Concentration of Cell-sap in Plants.

A paper in Czech—" Observations on *Caulerpa prolifera*, by Dr. S. Prát, has an English translation appended. Dr. M. Soucková contributes a paper entitled, " Rapports corrélatifs entre la lame et la production des racines chez les feuilles isolées."

Professor Nemec himself gives an account (in German) of researches upon Eriophyide Galls, and there are two other papers in German by Dr. Senft dealing with mnioindican, a new plant dye from the mosses mnia.

A plea is made for other Institutes to send their publications in exchange.

J. G. F .D.

Popular Science Monthly. July, 25 cents. 250, Fourth Avenue, New York.

The programme on the cover, Inventions, Discoveries, Radio, Automobiles ,Aviation, Home Workshop, is a modest statement of the contents of the above profusely illustrated magazine.

A Brief Outline of the History of Science, by J. G. F. Druce, M.Sc. (Lond.), R.Nat. Dr. (Prague), A.I.C., F.C.S., III + 151. Price 5s. net. The *Chemical News*, Ltd., Merton House, Salisbury Square, London, E.C.4.

Dr Druce's book is a concise account of the main achievements in science, and it includes a wide range of subjects, such, for example, as astronomy, medicine, biology, botany, geology, physics, chemistry, etc., concluding with hydrogen-ion concentration and atomic structure.

Of particular interest to the student should be the style of the author. There are various styles adopted by teachers, but the one under consideration has the merit of direct simplicity. Science is growing cumbersome and there is a tendency to excessive elaboration and sentences are often so constructed as to destroy the unity of thought. Dr. Druce attains to an ideal standard in the writer's opinion. For example on page 134, the telegraph is described thus:—" The telegraph depends upon the fact that when a circuit is made and broken at one point it is made and broken at all points."

Considering that the book is a summary of scientific progress, the author is able to condense much information in a small space, at the same time give the student ideas which he can assimilate.

The account of the Royal Society, which could be written on a post-card, is an example of all that is necessary for a student to commit to memory. And the illustrations on pages 64 and 65 enhance the value of the book; these being reproductions of the title-page and coat-of-arms in Bishop Spratt's history of this Society.

The author has exercised great care in preparing this little volume, and those who find that it is not always in agreement with current ideas must go to the originals as erroneous knowledge has crept into literature. In this connection it is interesting to note that in speaking of the discovery of the Bunsen burner, the author says:—" From his [Bunsen's] studies of the combustion of gases, the burner that goes by his name was devised." As a matter of fact, while Bunsen inspired the idea, he did not actually invent the burner " that goes by his name."

In this age of great activity in science, a book of this kind is most welcome, and it can safely be used as a standard outline.

The Technology of Wood Distillation, by M. Klar, translated by Alexander Rule, M.B.E., D.Sc., etc. 496 pp. Price 25s. net. London: Chapman and Hall, Ltd., 11, Henrietta Street.

The author of this work has been a close investigator of wood distillation for many years, and has very materially contributed to its development and improvement, as is evidenced by several valuable German patents which he registered since 1903. The present is the second edition of what can be regarded as both an exhaustive and standard work on the subject. The appreciation extended to the first edition was shewn by the fact that it soon became exhausted, and it is safe to assume that the present work, which is much more comprehensive and complete, will meet with equal favour. The author is fortunate in having such an able and painstaking scientist for a translator as Mr. Rule. There is a very full index and the letterpress and binding leave nothing to be desired.

The Chemistry of Enzyme Actions, by K. George Folk (Harriman Research Laboratory, N.Y.). Second and Revised Edition. 250 pp. New York: The Chemical Catalog Company, Inc., 19, East 24th Street.

The present work is one of a series of very useful monographs, which have been issued in conformity with a decision of the inter-allied conference of Pure and Applied Chemistry, which met in London in 1919, according to which the American Chemical Society was to undertake the production and publication of scientific and technologic monographs on chemical subjects. The National Research Council, in co-operation with the Chemical Society, undertook the production of critical tables of chemical and physical constants. Thereupon, influential trustees were appointed, and the work of printing the Chemical Society series was entrusted to the Chemical Catalog Company. Owing to the fact that knowledge of enzyme actions is yet far from complete, the present work, while interesting and as complete as available data would permit, is not, and does not claim to be, anything like the final word on the subject. We learn that many laboratories are actively investigating enzyme actions, and it ought to be possible in the near future to produce a more complete work. At the same time, the present book (which is well printed), contains a large amount of useful knowledge, and will be found generally interesting and of help to investigators in all countries.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

18,659.—Boake, Roberts & Co., Ltd., A. —Chlorination of organic compounds. July 22nd.

18,741.—Coxon, T.—Production of solid compounds of ammonia, carbon dioxide, and water. July 23rd.

18,761.—Isajev. V.—Production of bornyl esters from pinene, etc. July 23rd.

18,920.—Jones, . . C.—Distillation of zinc and production of zinc oxide. July 25th.

18,716.—Metallbank und Metallgurische Ges. Akt. Ges.—Production of sulphuric acid. July 22nd.

Specifications Published this Week.

236695.—Lefebure, V.—Process for the manufacture of plasters from anhydrite.

220,936.—Naamlooze Vennootschap Philips' Gloeilampen-Fabriken. — Process for separating hafnium and zirconium.

236,739.—Hamilton, W. B., and Reid, F. —Process of reducing metal oxide.

236782.—United States Smelting, Refining and Mining Co.—Purifying antimonial lead alloys or other antimonial metals.

Abstract Published this Week.

234956.—Dyes.—Soc. of Chemical Industry in Basle and Schobel H., 26, Bergalingerstrasse, both in Basle, Switzerland.

Monoazo and disazo dyes are produced by coupling β-resorcylic acid with one or two molesular proportions of the same or different diazo compounds, one at least of which is an *o*-oxydiazo compound of the benzene series. When chrome-printed on cotton they yield fast yellow-brown, red-brown, violet-brown ,etc., shades. According to examples, dyestuffs are obtained from one molecular proportion of β-resorcylic acid and the diazo compounds of the following amines:—1 or 2 mols. 4-nitro-2-aminophenol, 1 or 2 mols. 4-chlor-2-aminophenol-5-sulphonic acid, 1 or 2 mols. 4-nitro-2-aminophenol-6-carboxylic acid, 1 mol. 4-chlor-2-aminophenol-5-sulphonic acid and 1 mol. 4:6-dinitro-2-aminophenol, 1 mol. 4-nitro-2-aminophenol-6-carboxylic acid and 1 mol. 1-aminobenzene-3-sulphonic acid, 1 mol. 2-aminophenol-4-sulpho-6-carboxylic acid and 1 mol α-naphthylamine.

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CRITICAL STUDIES ON METHODS OF ANALYSIS. XVI.—ZINC.

By LEON A. CONGDON, A. B. GUSS, AND F. A. WINTER.

(Contribution from the Department of Chemistry, Syracuse University.)

(*Continued from Page* 100.)

Six modifications of the gravimetric phosphate method for zinc were tried experimentally and the order of their average accuracy may be stated as follows, the most accurate coming first:—1, Findlay and Cumming's modification of the Dakin-Tamm method weighing the zinc as $Zn_2P_2O_7$; 2, Dakin's modification of Tamm's method, weighing the zinc as $ZnNH_4PO_4$, after heating the precipitate on a water bath for one hour before filtering; 3, modification of Dakin's method by weighing the zinc at $ZnNH_4PO_4$, after letting the precipitate stand four hours and filtering while cold; 4, modification of Dakin's method, weighing the zinc as $ZnNH_4PO_4$, after letting the precipitate stand 2½ hours and filtering while cold; 5, modification of Losekam and Meyer's modification of Tamm's method, weighing the zinc as $Zn_2P_2O_7$, after letting the precipitate stand 5 hours and washing the precipitate with a warm dilute solution of NH_4NO_3, instead of hot water as suggested by Losekann and Meyer; and 6, Losekann and Meyer's modification of Tamm's method weighing the zinc as $Zn_2P_2O_7$, using hot water to wash the precipitate of $ZnNH_4PO_4$. All these methods gave an accuracy of less than 0.20% of the theoretical amount of zinc in the sample examined, with the exception of Losekann and Meyer's method, which, if followed as given by them, will give 1.5% less than theoretical, and as modified, will give 0.27% to 0.5% less than theoretical.

Three modifications of the gravimetric sulfide method for zinc were experimentally performed and the order of their accuracy can be laid down as follows:—1, Anthony Guyard's method of precipitating the zinc as zinc sulfocarbonate by ammonium sulfocarbonate, the precipitate heated at 100° to 110°, then heated gently to constant weight and weighed as ZnS; 2, by precipitating the zinc with H_2S in sodium acetate solution as zinc sulfide, drying at 100° to 105° on a weighed filter paper and weighed as zinc sulfide; 3, by precipitating the zinc with H_2S in ammonium acetate solution as zinc sulfide ,drying at 100° to 105° on a weighed filter paper and weighnig as ZnS. Only one of these methods gave results within 0.2% of the theoretical, the last two mentioned giving results within 0.4% less than the theoretical.

Three modifications of estimating zinc as sulfate were undertaken and their accuracy may be classified as follows:—1, Precipitating zinc by ZnS by H_2S in potassium acetate solution and the sulfide changed to a sulfate by H_2SO_4 and weighed as sulfate; 2, Precipitating zinc as ZnS by H_2S in ammonium acetate solution and the sulfide changed to a sulfate by H_2SO_4 and weighed as sulfate; 3, precipitating the zinc as ZnS by $(NH_4)_2S$ and the sulfide changed to a sulfate by H_2SO_4 and weighed as $ZnSO_4$. These three methods were within 0.2% of theoretical on the average.

Three modifications of determining zinc as an oxide were examined and their accuracy may be stated as follows:—1, zinc precipitated as $ZnPy_2(SCN)_2$ by ammonium sulfocyanide and pyridine in neutral solution, the precipitate ignited to ZnO to constant weight and weighed as such; 2, zinc precipitated as ZnS by sulfur in a solution of KOH, ignited to the oxide by a muffle and weighed as ZnO; 3, zinc precipitated as ZnS by H_2S in potassium acetate solution and strongly heated to constant weight to the oxide and weighed as ZnO. These

methods gave results within 0.2% of theoretical with the exception of the last named method which was within 0.4% less than theory.

Three modifications of the volumetric $K_4Fe(CN)_6$ method by use of different indicators were tried and the accuracy classed as follows:—1, using uranium acetate as indicator; 2, using uranium nitrate as indicator; and 3, using uranium chloride as indicator. To this may be added fourth in accuracy, the Percy Walker volumetric neutralisation method by adding an excess of standard acid to the $ZnNH_4PO_4$ precipitate and titration of the excess of acid with standard alkali. These methods gave an accuracy within 0.2% of the theory with the exception of Percy Walker's neutralisation method which, while giving good checks, gave results a little over 0.1% higher than the theory.

4.—Procedure for Most Accurate Methods for Zinc.

Zinc freed from interfering elements may be determined most accurately by one of the following methods which will give the best concordant results in the hands of the average analyst.

(a) Authors' modification of A. Thiel's method:—Take nearly 0.2 gram of the sample in about 50 cc. of solution, add 10 cc. of a 10% solution of potassium acetate. Then add H_2S under pressure, filter on filter paper and place filter paper with precipitate in a weighed silica crucible. Add HCl to dissolve the sulfide and then a small amount of dilute H_2SO_4. Heat with a Bunsen burner. After all the carbon has been burned off and the ppte heated, add a very small amount of concentrated H_2SO_4 to the ignited mass to convert to the sulfate any of the zinc that might have turned to an oxide. The difficulty of the method is to carefully drive off the excess of H_2SO_4, otherwise it might spatter, and also carefully ignite so as not to change the sulfate to an oxide. The zinc is weighed as $ZnSO_4$. In Thiel's original method, he weighs as sulfide and heats the sulfide to 120° in a current of hydrogen to get rid of the last traces of H_2S. He also used ammonium acetate instead of potassium acetate solution as medium for H_2S precipitation. The method as it now stands is nearly a new method of the authors, and a glance at the table of results will show concordant reliable findings as compared to other methods experimented upon.

(b) G. Spacu's (31) gravimetric method where zinc is weighed as the oxide is as follows:—Add a slight excess of NH_4SCN to a neutral solution of a zinc salt, then a few drops of pyridine slowly and with constant and vigorous stirring. Collect the white precipitate of $ZnPy_2(SCN)_2$, after letting stand 15 minutes or more and wash the precipitate with a cold solution of a mixture made up as follows—0.3 gram of NH_4SCN, 0.2 gram $(NH_4)_2SO_4$, dissolved in 100 cc. water. Dry the precipitate and the filter, and ignite over a Teclu burner until constant weight is obtained and weigh as ZnO. This procedure will also separate Zn from Mg and the alkaline earths. In the investigation of this method it was found necessary to heat the precipitate at least half an hour before constant weight was obtained, and to ensure the zinc was all in the form of an oxide, otherwise high results will be obtained. Best results were obtained by using 0.2 to 0.3 gram sample (in this case the sample was zinc nitrate). The method was found exceedingly accurate in the hands of average analyst. It is quite necessary that the solution precipitated be neutral, as best results are obtained under these conditions. It is also found that mercury, copper, lead, and cadmium form similar compounds quantitatively, and hence must be separated from the solution precipitated.

5.—Summary and Conclusions.

(a) A study of the literature for the estimation of zinc is given with over one hundred original references.

(b) A sample of c.p. zinc nitrate of known purity was analysed by nineteen different modifications for the estimation of the zinc content, and compared with the theoretical percentage of zinc in the sample.

(c) The most accurate and concordant method found was that developed by the authors modified from A. Thiel's ammonium aetate sulfide method, wherefrom the authors practicaly develop a new method by precipitating the zinc as sulfide in potassium acetate solution, changing the sulfide to a sulfate by H_2SO_4 and weighing the zinc as $ZnSO_4$. Thiel's original method was not found very accurate, but gave results a little over 0.3% less than the theoretical.

(d) Another accurate concordant result method found was that of Spacu (31), where the zinc is precipitated in neutral solution by NH_4SCN and pyridine, and the $ZnPy_2(SCN)_2$ resulting is ignited to ZnO

by the Teclu burner and weighed as ZnO. This method is applicable in the presence of magnesium, but it is found that Cu, Pb, Hg, and Cd interfere as they also form similar quantitative compounds.

(e) The nineteen methods or modifications experimentally studied were as follows :—Six modifications of the phosphate method; three modifications of the sulfide method; three modifications of the sulfate method; three modifications of the oxide method; three modifications of the volumetric $K_4Fe(CN)$ method; and Percy Walker's volumetric neutralisation method.

(f) The following methods for zinc were studied from the theoretical and practical standpoint :—As phosphate; sulfide; sulfate; oxide; carbonate; mercury thiocyanate; by electrolysis; volumetric potassium ferrocyanide; volumetric sulfide; volumetric thiocyanide; volumetric oxidation methods; volumetric neutralisation methods; volumetric potassium cyanide methods; and by miscellaneous methods such as indirect gasometric, colourimetric and turbidimetric methods.

(g) All of the nineteen methods or modifications experimentally examined gave results within 0.2% with the exception of the following Losekam and Meyer's modification of Tamm's phosphate method; A. Thiel's original H_2S method in ammonium or sodium acetate solution; A. Thiel's method by changing the ZnS to the oxide, after precipitation by H_2S in potassium acetate solution. All of Thiel's methods gave results a little over 0.3% less than theoretical, but if modified by the authors' method as outlined in this paper and weigher as sulfate, it was found that this gives very concordant results. Losekam and Meyer's method as phosphate ,if carried out as given in their original paper, was found to give over 1.5% less than theoretical. An attempt was made to modify this method by using NH_4NO_3 solution instead of water to wash the precipitate, which brought results nearer theoretical, giving values from 0.27 to 0.5% less than theoretical.

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METEORS.

By F. H. Loring.

(*Continued from Page* 104.)

In preparing this article, several features were not mentioned which are of interest. They are here added as notes :—

1.—According to Young (see his "Manual of Astronomy," 1912 issue) the Perseids are yellow and move with medium velocity. The Leonids are very swift (we meet them), and they are of a bluish-green tint, with vivid trains. The Andromedes are sluggish (they overtake the earth), are reddish, being less intensely heated than the others, and usually have only feeble trains.

2.—About 100 meteoric radiants are recognised and catalogued, the most conspicuous according to Young (*loc. cit.*) were the Draconids, January 2; Lyrids, April 20; Aquariids, May 6; Aquariids II., July 28; Perseids, August 10; Orionids, October 20; Leonids, November 14; Andromedes, November 28; Geminids, December 10.

3.—When meteoric showers are at their best, thousands appear in a few minutes. Some of the swarms are now evidently scattered and partly used up (burnt out) so that their number has been reduced, but, in addition to this cause of diminution, the orbits of meteors ,like comets, are subject to perturbations when they happen to pass close to the planets, so that there is always some uncertainity attending their appear-

ance, unless these causes are allowed for. Moreover, the distribution must also be taken into account, as mentioned in the early part of this article. If they come from comets, the breaking up of the comet at one time or another was a factor.

4.—Referring to the " B-number grouping " for the Andromedes, it is curious that Young, in his manual referred to above, page 470, should have said (where here italicized) that for " the Leonids the interval is about thirty-three years and for the Andromedes *usually thirteen but sometimes only six or seven.*" The value 6.72888 (6.729) is the period of Biela's comet as taken from a catalogue of the elements of a considerable number of comets (see *Memoir Brit. Ast. Ass.*, 1925, Vol. XXVI., part 2, by Crommelin). In this connection there are other statements in Young's manual which seem to throw a faint light on the B-number relationship which may, notwithstanding the note of caution given, be significant of a connecting principle. Be this as it may, the following quotations are of interest, these being from pages 430 to 432. " *Comet families origin of periodic comets.* It is clear . . . that the comets which move in parabolic orbits cannot well have originated within the limits of the solar system, but must have come from a great distance. As to those which move in elliptical orbits, it is a question whether we are to regard them as native to the system or only as 'naturalised,' or perhaps mere sojourners for a time; but it is evident that in some way many of them stand in peculiar relations to Jupiter and to other planets. The short-period comets, those which have periods ranging from three to eight years, are now recognised and spoken of as Jupiter's *family of comets.* About thirty are known already, of which fifteen have been observed twice, or oftener—some of them a dozen times. Similarly, Saturn is credited with two comets; Uranus with two, one of which is Temple's comet [1866 I], closely connected with the November meteors and due to appear in 1900, but not seen. Finally, Neptune has a family of six; among them Halley's comet, and two others which have returned a second time to perihelion since 1880. *The capture theory.* The now generally accepted explanation as to the origin of these *comet-families* was first suggested by Laplace, *viz.*, that the comets which compose them have been 'captured' by the planet to which they stand related. A comet entering the system in a parabolic orbit and passing near the planet will be disturbed and either accelerated or retarded. If it is accelerated, then according to equation . . . . the major axis will become negative, the orbit will be changed to an hyperbola, and the comet will never be seen again. But if the comet is *retarded*, the semi-major axis will become finite and the orbit will be made *elliptical*, so that the comet will return at each revolution to the place where it was first disturbed; it will become a *periodic comet*, with its orbit passing near to the orbit of the disturbing planet. It will not, however . . . . revolve round its capturer like a satellite. The focus of its new and diminished orbit still remains at the sun. But this is not all. After a certain time the planet and the comet will be sure to come together again at or near this place. The result then *may be* an acceleration which will enlarge the comet's orbit, or even transform it to a parabola or hyperbola; but it is an even chance at least that the result may be a *retardation*, and that the orbit and period may thus be further diminished. This may happen over and over again, until the comet's orbit falls so far inside that of the planet that it suffers no further disturbance to speak of. Given time enough and comets enough, the ultimate result would necessarily be such a comet family as really exists. It is not *permanent*, however; sooner or later, if a captured comet is not first disintegrated, it will almost certainly encounter its planet under such conditions as to be thrown out of the system. A recent investigation, however, by Callandreau, upon the disintegration of comets by the action of the sun and the planet Jupiter, shows that the limit of distance at which such an effect is possible is quite considerable, and that the breaking up of a comet ought not to be very unusual. He suggests that the number of the comets of Jupiter's family has probably thus been largely increased by the division of single comets into several—a suggestion which greatly relieves very serious objections that have been urged against the capture theory."

Corrections.

Page 100, second column, eleventh line from bottom, " Meterological " should read " *Meteorological.*"

Page 103, first column, fourth line from top, " Tables III. to VI." should read,

"*Table VIII.*" In same column delete first line of third paragraph and substitute "*Referring to Table VIII., the expression*".

In Table VIII., "415.07" should read "415.09," but this is a minor matter.

In thirteenth line, column 1., page 101, August 14th issue; for "C.P. Oliver," read "*C. P. Olivier.*"

MINES AND MINERAL DEPOSITS OF CANADA.

By R. P. D. Graham.

Institution of Mining and Metallurgy,

May,25, 1925.

The President, Sir Thomas H. Holland, said that the next paper open for discussion was one which had been presented to the Empire Mining and Metallurgical Congress held last year at Wembley. Mr. Graham's paper had been prepared at the request of the Canadian Institute of Mining and Metallurgy for that Congress. Mr. Graham was the Chairman of the Montreal Branch of the Canadian Institute.

As Mr. Graham was not present, the President undertook to bring to the notice of the members what had struck him as the principal points which were likely to give rise to discussion.

Mr. Graham's paper opened with a historical sketch of the development of the mineral resources of Canada. The first thing that struck one on reading the paper was a reminded that Canada was a very old Colony, opened up by the French, taken over by the British in a 'friendly' way in 1759, and from that time onward developed mainly in the eastern sections before the western part of the Dominion was connected up by the Canadian Pacific Railway in 1885.

In 1672, an account was published in Paris by Nicholas Denys of the development of the coal resources of Cape Breton Island; in other words, when John Evelyn was protesting in London against the use of coal, which he said was poisoning the atmosphere of the metropolis, Canada was already opening up her coal resources.

The author then went on to show that in 1737 an iron-smelting furnace was established at St. Maurice, between Montreal and Quebec, and that iron of very fine quality was turned out for more than a century. He then pointed out that casual discoveries were made in different parts, almost entirely in Eastern Canada, and that among others, in 1774 ,there was published a map in which there was noted a deposit of argentifegrous galena on the eastern shore of Lake Temiskaming. Some of the discoveries at the time, made accidentally, were within a few miles of what afterwards became well-known to the world as the Cobalt district.

That discovery was allowed to lie idle for 160 years or so, until Northern Ontario was opened up by a railway. He would refer subsequently to the influence of railway development in Canada on the opening up of the mineral resources.

The first serious period of development commenced in 1843, when the Geological Survey of Canada was instituted by what was then the Provincial Government and placed under the directorship of Sir William Logan. That period was interesting to the pure geologist because about the same time the greater Dominions began to realise that a geological survey on systematic lines was necessary for the opening up of mineral resources. The Indian Geological Survey was founded in 1850 by the employment of Dr. Thomas Oldham, and developed along lines very similar to those of Canada, in the sense that the survey was made one department for the whole country, instead of being placed under Provincial Governments and sub divided, as they had very unfortunately been in Australia.

Most mining discoveries were within 20 to 10 years of to-day. Possibly more than half the mineral output of Canada had been developed within the 10 years. The author pointed out that in 1886 the total mineral production of the Dominion had a value of a little over $10,000,000. Sever years later, namely, in 1893, the value had doubled. In 1903 the value had risen to $61,000,000, and at the present time the annual production of minerals in Canada might be taken to be worth well over $200,000,000. That gave an idea of the very rapid and uninterrupted development which had occurred in the Dominion since 1886.

SOME APPLICATIONS OF GEOLOGY TO MINING METALLURGY.

In his presidential address before the Australasian Institute of Mining and Metallurgy, Professor Ernest W. Skeats, D.Sc., A.R.C.Sc., F.G.S., took the above as his subject.

Dealing with oil, he said :—

"The remarkably active search for oil in recent years in Australasia may be sufficient justification for the consideration of the possibilities of its occurrence in commercial quantities and for setting out some of the geological controls which dominate the problem. Perhaps no form of mining activity lies so legitimately within the domain of the geologist as the search for oil and the development of oil-fields when found. Evidence has been adduced in the laboratory that petroleum of various kinds can be made from inorganic materials by chemical processes, and following on these laboratory experiments the hypothesis has been advanced that metallic carbides are present deeply buried within the earth from which petroleum and natural gas is developed by chemical changes. But such oil formed chemically from inorganic materials is invariably optically active, and its optical activity is due to the presence of cholesterol and phytosterol, materials present in animals and plants respectively.

The physicist to some extent, however, may claim a part in the exploration for oil, since Becker* has shown that there is some evidence of special local magnetic disturbances in some of the important producing oil regions.

In addition to this, Baron von Eotvös†, by the use of his Eötvös Torsion Balance, has shown that in Transylvania low gravity values occur over the great cores of rock salt, and similar defects of gravity occur in the same region over some of the great domes which are great storehouses of natural gas. In recent years the d'Arcy Exploration Company‡ is using this method in searching for petroleum and natural gas in Hungary.

In spite of the experiments of the chemists and the observations of the physists, the great balance of available evidence goes to show that the principal producing fields of oil and gas owe their supplies to the alteration of organisms entombed in sedimentary rocks.

It is a much-debated question whether animals or plants play the more important part in the production of workable oil pools.

White‖ has developed the important principle that in the geo-chemical stages of development both coal and oil react to physical influences in much the same way, and that when both are found in the same geological series the degree of concentration of the coal, measured by its percentage of carbon, may be an indication of the stage of development of the oil. More specifically where the coal contains more than 67-70% of fixed carbon, chances for finding oil in the vicinity are not good (though gas pools may be found). The lowest rank oils, with considerable asphalt, are found in regions and formations where the coal deposits are leas altered, and the lighter, higher rank oils, on the whole where the coal has been brought to the corresponding higher ranks. The principle therefore becomes useful in exploration where oil is associated with coal, but only where the two are associated in the same series of rocks. These observations of White would in the regions where they ocur, tend to associate the formation of petroleum with the alteration of plants, but in many oil fields animals, and especially marine animals of a lowly kind, are claimed to be most closely associated with the origin of petroleum.

If we set out the principal conditions which, with our present knowledge, appear to be requisite for the formation and storage of petroleum, we find that they are :

1. Abundant life, either animal or vegetable, in the sediments;
2. Lagoon or off-shore shallow water marine muds or deltaic deposits, associated with sands or other porous rocks;
3. Partial bacterial attack on the organisms before they are sealed up, by means of which the cellulose and nitrogenous contents are destroyed while the fatty parts remain;
4. Slow geochemical change of the fatty residues with the production of oil or gas;
5. Migration of the oil and gas, from the muds or shales where the organisms accumulated, to porous reservoirs such as sands or limestones;
6. The mechanism of migration of the oil and gas may be largely controlled by surface tension and capillarity effects;
7. Within the porous reservoirs the movements of oil and gas appear to be controlled by the structural attitude of the containing rocks, the oil and gas moving up the dip of the beds under gravitative control;
8. Suitable structural conditions for the concentration of oil and gas within the porous rocks. These conditions may include :

(a) Lenticles of sand within les porous sediments;
(b) Anticlines, domes, or 'terrace' structures;
(c) The up-dip migration of the oil may be arrested by a sealed fault, a dyke or a volcanic plug.

9. The most favourable conditions arise in regions of gentle dip, leading to concentration of oil from a wide area, combined with more defined folds giving local concentration into oil pools.

Authentic surface indications of the existence of oil or gas below the surface include the finding within the area of gas seeps, oil seeps or deposits of bitumen.

Spurious indications include such phenomena as films of oxide of iron on the surface, intermittent exhalations of marsh gas from swamps, drifted lumps of bitumen, substances such as 'coorongite' produced at the surface by the alteration of algæ, and finally altered marsupial guano.

Summarising the favourable conditions for the formation of oil they may be stated to include the existence of abundant organisms in lagoon or shallow water marine muds or deltaic deposits, associated with porous rocks, and suitably altered by bacterial and chemical changes to petroleum. The containing rocks by folding develop suitable structures for concentration. The rocks, however, must not be so disturbed by faulting as to lead to the escape of all oil, or so compressed by earth pressures or chemical deposition that porosity is lost, as is commonly the case in rocks of high geological antiquity. Further, it is usual to find in oil-bearing regions seepages of gas or oil, not necesarily, or even usually, in the most favourable positions for boring, but in the neighbourhood of favourable structures."

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* *Relations between local magnetic disturbances and the genesis of Petroleum, U.S. Geol. Surv., Bull.* 401, 1909.

† *Comptes Rendus XVII. ème Conf. de l'Assoc. Geodes. Internat., Hamburg,* 1912, pp. 427, 437.

‡ *Rybar. The Eötvös Torsion Balance, and its application to the finding of mineral deposits. Econ. Geol., Oct.-Nov.,* 1923, p. 639.

|| *D. White. Wash. Acad. Sc. Journ. Vol. V.,* 1915, pp. 189-212.

General Notes.

QUICKLIME AND HYDRATED LIME FOR USE IN THE PURIFICATION OF WATER.

(*Circular of the Bureau of Stardards, U.S.A.*)

Definition of Lime.

Quicklime is the product resulting from the calcination of limestone. It will slake when water is added to it, and this slaking is accompanied by an evolution of heat, and increase in volume, and the formation of calcium hydroxide. Hydrated lime is a dry powder which is made by treating quicklime with enough water to satisfy its chemical affinity.

Use of Lime in Water Purification.

In the treatment of water for public supplies lime is used alone or with iron sulphate to produce a precipitate which assists in the clarification of the water and in the removal of bacteria by filtration. Lime is used sometimes to partially soften the water.

Lime and soda ash are used together for softening water. Quicklime is generally used in municipal purification plants and hydrated lime in smaller softening plants.

Quality.

The constituents other than calcium oxide ordinarily found in lime, and which include underburned and overburned lime, retard the slaking process. The presence of any inert material will thus introduce delays which reduce the efficiency of the equipment.

Packing.

Quicklime is shipped in bulk in carload lots or in wooden barrels or metal drums holding 180 or 280 pounds each, or in waterprrof bags holding 180 pounds. Hydrated lime is shipped in paper bags holding 40 or 50 pounds net each.

Marking.

Each package, or each carload of bulk material, shall be legibly marked with the names of the consignor and the consignee, and with some means of identifying the particular contract on which the shipment is made. This information is in addition to that required by the Federal lime barrel law.

Slaking.

When lumps of quicklime are immersed

in water, they shall disintegrate readily into a suspension of finely divided material.

Composition.

The standard of composition for quicklime for use in water purification shall be a content of 90 per cent. available lime; for hydrated lime a content of 90 per cent. available calcium hydroxide.

Basis.

The percentages enumerated herein are based on the sample taken at point of shipment.

THE AUSTRALIAN INSTITUTE OF MINING AND METALLURGY.

The report of the proceedings for 1924 shews that the above institute had a year of useful activity and is performing an important part in the science of mining and kindred subjects at the Antipodes. The headquarters are at Melbourne.

THE LOST PROPERTY OFFICE.

Mr. Sydney Skinner, writing from 19, Abingdon Street, London, S.W.1., says :—

"The figures published in the London newspapers relating to the enormous quantity of property lost in public vehicles and the streets are a significant revelation of our failure, as members of a business nation, to apply business habits to our personal affairs.

The fact is, of course, that, with the speeding up of modern life, we move about in a more highly concentrated mental state. Hence, it is not surprising that 170,000 articles were lost in public vehicles in the Metropolitan area last year, in addition to 160,670 on the streets, and 350,000 on the railways.

If the figures for Birmingham, Leeds, Manchester, Liverpool and the large provincial towns were calculated, it would, I think, be found that the price of what is referred to, somewhat erroneously as forgetfulness or carelessness, would run into hundreds of thousands of pounds a year.

I criticise the diagnosis of carelessness advisedly, for this is an age of increasing personal efficiency, and our 'carelessness' in small matters of personal life increases in ratio to our growing responsibilities in business and professional matters and to the 'rush' of modern life.

The application of method would solve automatically our little worries, and the novel system of Monomarks, evolved by Mr. William Morris, about which there has been much newspaper discussion, provides —amongst other important services—a method of reliable identification which would substantially lessen the work of Scotland Yard and the provincial police in tracing ownership of lost property, and, moreover, would save the general public this enormous loss."

BRITISH COAL AND FOREIGN CEMENT.

Board of Trade figures recently issued show that 100,209 tons of foreign cement were imported into this country during the six months ended 30 June.

As evidence of the loss caused to our mining industry by such importations as this, the Cement Marketing Company point out that the manufacture of this amount of cement in Great Britain would have meant orders for more than 50,000 tons of British coal. The cement was brought over principally in foreign ships, and £253,071 in cash went abroad to foreign firms.

THE MANUFACTURE OF PURE SODIUM CHLORIDE.

(*Extract from article by* J. A. Pelling *in Journal of the Chemical, Metallurgical and Mining Society of South Africa.*)

The following is a discussion on the manufacture of pure sodium chloride from brines containing it in the presence of sodium sulphate. Certain salt producers of the Union have for years been struggling to produce a salt free from sodium sulphate from such brines. Common salt as sold in South Africa to-day varies greatly in quality, and mostly contains varying quantities of sodium sulphate. Typical analyses show as much as 18 per cent. Na_2SO_4 in the salt, whilst quantities of from 3 per cent. to 6 per cent. are common. The presence of this impurity is a serious handicap to the salt industry of the Union, which produces altogether over 80,000 tons of salt per annum.

Whether the public will ever demand a pure salt cannot be foretold, but the imports of Cheshire salt certainly reveal that in the dairy, soap, and meat preserving industries there is a demand for the pure article.

This pure article can be made in South

Africa, and we will briefly consider the question now of its manufacture.

The obvious method of treating the brine containing Na_2SO_4 to remove this substance by adding $CaCl_2$ apparently does not find favour with the manufacturers, although the settlement of the resulting gypsum precipitate is a very rapid operation, and this substance is not without value on the South African market. We will briefly consider the prevalent South African methods of producing salt from brines containing sodium sulphate and sodium chloride. Generally two distinct classes of salt are made.

(a) Solar salt, produced by direct evaporation of the brine in solar pans, and generally consisting of large crystals of NaCl containing smaller Na_2SO_4 crystals as impurity.

(b) Salt produced by artificial evapora tion in open fired pans and having a fine grain. The present methods of producing this type of salt are comparatively costly, and generally this salt is more impure than solar salt. The pans become shockingly scaled with Na_2SO_4 during the boiling, thereby enormously adding to the coal bill, owing to the non-conducting thermal property of the scales. Moreover, the method of drying the salt when produced seems to offer considerably scope for improvement. At present it is dried in blocks and subsequently re-ground. The blocks as made contain sulphate liquor adhering to the crystals, and this remains as an impurity in the salt, apart from the Na_2SO_4 crystals present from the boiling process.

In the case of solar salt crystals, the mother liquor drains away far more completely, and thus assures better purity. Even if the present method of boiling out salt is persisted in, better means of mechanically handling the salt with a view to freeing it from mother liquor before drying should be introduced if the industry can spare the capital cost.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday ,May 1 ,1925.

W. L. BRAGG, M.A., O.B.E., F.R.S., Langworthy Professor of Physics, Victoria University of Manchester.—*The Crystalline Structure of Inorganic Salts.*

The examination of crystalline bodies by means of X-rays has enabled us to discover the positions of the atoms in the crystal. In the earlier period of X-ray analysis it was only possible to do this when the atoms were arranged according to a simple pattern of high symmetry. Experience has increased the range of substances to which the new methods can be applied, and we can now assign structures to relatively complex crystals, basing the proposed structure on the manner in which the crystal diffracts the radiation.

The study of the crystalline structure of organic and inorganic compound has revealed certain broad distinctions between these two classes of crystals. The crystalline arrangement throws new light on those differences in the structure of the molecule which have made it convenient to distinguish organic from inorganic chemistry. No exact line can be drawn between the two classes of crystals, and yet the main features are sufficiently different to make the classification useful. The organic crystal appears to be composed of definite molecules. Inside each molecule the atoms are bound together by forces so local, and so rigid, that an addition to one part of the molecule hardly affects the rest; these molecules are then massed together by comparatively weak forces into a crystalline structure. The form of the inorganic crystal suggests that the bonds between atom and atom are not limited to certain directions; the molecule is more fluid, and an addition to one part profoundly disturbs the relationship of all the rest. It must be this molecular fluidity which makes it so hard to apply the ideas of stereochemistry to inorganic chemistry, althought they have been so successful in explaining the organic compounds.

Our powers of X-ray analysis are as yet very incomplete, and it is difficult to find the positions of the atoms in complex structures. The complexity of a structure depends on the number of parameters, or degrees of freedom permitted by the symmetry, which fix the positions of the atoms in its pattern. At the present time any structure with more than half a dozen of these independent parameters presents a difficult problem; whereas crystals with two or three parameters are comparatively simple. For several reasons the inorganic salts can be analysed more completely than organic compounds. In the first place, the number of atoms in the inorganic molecule is generally smaller than that in the organic

molecule, and owing to the power or re-adjustment in the former class of compound which has already been mentioned, the atoms often take up a symmetrical arrangement and this symmetry makes the X-ray investigation more easy. Every requirement of symmetry which must be satisfied by the atom reduces the number of variable parameters in the structure, and confines the atom to certain planes, lines, or points from which it cannot move. Further, in a series of inorganic crystals it is often possible to replace one atom by another of similar chemical properties without altering the crystalline structure. Now the heavier atoms scatter X-rays more than the lighter atoms. If, therefore, we wish to find the position of the metal atoms in an inorganic salt, and a crystal of the series is available in which the metal has a high atomic weight compared with the other constituents, it is an easy matter to fix its position. The same process can often be carried out with a heavy atom in the acid radical and a light one in place of the metal. In order to aid the X-ray examination we are using a method which is precisely like the staining by means of suitable dyes, of certain parts of a microscopic preparation. In the organic crystal, the atoms of carbon, oxygen, and nitrogen are almost indistinguishable by means of X-rays since they are so slose in the periodic table, and with the exception of one or two compounds it has so far been impossible to fix their positions.

The inorganic salts are interesting, not only because we know more about their structure, but also because they lend themselves more readily to mathematical treatment. We may compare this case of crystal equilibrium to the engineering problem of calculating the stresses to which the members of a girder system are subjected. If the number of constraints is the minimum requisite for rigidity, these stresses can be directly calculated by simple laws of mechanics. If the whole structure is too rigid, much more detail must be known about the structure in order to calculate the stresses. The inorganic crystal represents the structure with the minimum number of constraints. We can try and explain the properties of the crystal as a whole by making certain simple assumptions about the forces between the atoms. It is certain that the real atomic properties are more complex than those represented by these simple assumptions, but it is interesting to see how far one can get towards an explanation with their aid. One can, for instance, explain a number of crystalline properties by assuming an atomic model of the following kind :—
closer approach.

(*a*) The atom consists of a symmetrical electronic structure surrounding the nucleus in which the charges on the electrons and on the nucleus do not balance, so that the sum of the charges is sometimes positive, structures sets in very rapidly and prevents sometimes negative.

(*b*) When the atoms approach within a certain distance of each other a force of repulsion between their outer electronic

(*c*) When the atom is placed in an electric field it becomes polarised. Its positive and negative parts are drawn in opposite directions, and it is surrounded by a field like that of an electrical doublet.

With the aid of these assumptions qualitative explanations have been given of the formation of inorganic compounds (Kossel) and quantitative explanations of the heats of formation, heats of solution, latent heats of evaporation, and elastic properties of the inorganic crystals (Born and Landé, Madelung, Fajans, and others). Their highly interesting investigations have been applied to crystals of a symmetrical and simple type, such as the rock-salt structure. The quantitative agreement between calculated and observed data is most striking, and shows that the assumptions which have been made are not far from the truth. I do not wish to discuss their results here; I quote them to show how far this atomic model explains the facts, as I wish to use it in examining the more complex salts which we have analysed by X-rays.

The force which causes two atoms to repel each other when they approach closely is very interesting. We do not know its origin, but it is clear that it sets in very sharply, and increases rapidly as the centres of the atoms get closer together. This is so much the case that each atom in the crystalline structure appears to be surrounded by a domain which it occupies to the exclusion of other atoms. We cannot define the size of this domain exactly, because the distance of closest approach of two atoms will always depend on the strength of the force driving them together, but the domain varies within narrow limits for the range of forces ordinarily present in a crystal. A knowledge of the domain associated with the atoms and molecular groups is most important in crystal analy-

sis, since it limits the possible configurations and confines the atoms to certain regions where they do not overlap too greatly. In a Friday evening discourse four years ago I gave some empirical figures for the radii of these atomic domains, and tried to show how these figures could be used to aid crystal analysis. I wish to take this opportuntiy of saying that I have considerably altered my views on this question. Other workers who have dealt with the subject have given alternative estimates of the domains which I believe to represent the physical facts far better than did my original figures; and, in addition, a more complete knowledge of crystal structures has shown how elastic the atomic domain is and what care is necessary in using the conception to help analysis. Nevertheless, its very great importance must not be lost sight of, for it is one of the principal aids we have in tackling a difficult crystal structure.

We do not know the exact dimensions of the electronic orbits, but such estimates as can be formed suggest that in a crystal such as rock-salt there are large spaces between the outermost orbits of neighbouring atoms. Each atom has its system of orbits quite distinct and widely separated from those of its neighbours. This is generally true where the charged atoms are of a symmetrical type and held together by electrostatic attraction. On the other hand, where the chemical evidence points to a linkage of the homopolar type, crystal analysis shows the atoms close together as if the electronic orbits were actually linked up.

A series of atomic structures such as O^{--}, F^{-}, Ne, Na^{+}, Mg^{++}, Al^{+++}, are supposed by Kossel to have a common configuration resembling that of neon itself. The charges on the atoms are due to the addition or removal of electrons required to give them the correct number for a neon structure. The scale on which the atoms are built must diminish from oxygen to aluminium, owing to the increasing nuclear charge, Al^{+++} being on about one-half the scale of O^{--}. The idea of an atomic domain can only be a very rough approximation to the truth, for in actual fact there must be a different law of force for every given pair of atoms; in this approximate sense, interatomic distances in simple crystalline structures are in agreement with the supposition that they obey an additive law, and that the dimensions of the domain are proportional to those of the atomic structures in a series such as have been given above. I drew attention to this additive law as an empirical fact in the discourse referred to avobe, but made the domains of the positive ions too large and those of the negative ions too small. A better in terpretation of the significance of the law was given by Wasastjerna in a paper on the "Radii of Ions,' in which due weight was given to the relative dimensions of the electronic structures. Recently Jones in a series of highly interesting papers has linked up the fields which give the repulsion between atoms of an inert gas, and the fields of the corresponding ionic structures in crystals.

PHYSICAL SOCIETY OF LONDON.

The Shakespeare Katharometer.

On June 12, 1925, a demonstration entitled *Some Experiments to Illustrate the Application of the Shakespeare Katharometer to Physical Research*, was given by Dr. H. L. Daynes, of the Cambridge Scientific Instrument Company.

The following characteristics of the instrument were pointed out :—

1 A direct reading is given without the withdrawal of any gas for analysis or disturbance of the conditions of the experiment,

2 The readings are very rapid. The half-value-period for hydrogen-air mixtures is of the order of 10 seconds, and is longer for gases of higher molecular weight. The actual relation between the periods for different gases is calculable from the diffusion constant for the mixture considered.

3 The capacity is small, being only about 0.5 cc. Small quantities of gas, therefore, give large changes of percentage in the mixture if the system to which the instrument is connected is also smal.

4 The instrument is sensitive to small changes of composition. With a reflecting galvanometer a charge of one part of hydrogen in 100,000 of air can be detected if the change takes place not so slowly that zero changes mask the deflection.

5 The instrument is essentially a differential one, and has all the advantages of the differential method in eliminating the effects of variations other than the particular one to be studied. The full sensitivity of the method may, therefore, be utilised in a great variety of experiments.

In illustration of the above points, the

following series of experiments was shown :

(a) Measurement of a small rate of flow of gas by addition of hydrogen at a known rate from an electrolytic cell, and measurement of the resulting percentage of hydrogen.

(b) The rise in CO_2 percentage in an enclosed space due to the respiration of a small bee. A few thousandths of a cubic centimetre were detectable.

(c) The leakage of CO_2 and H_2 from a few square millimetres of two rubber balloons was visible in a few seconds.

(d) A method of demonstrating the effect of " thermal diffusion " in producing separation of hydrogen from oxygen. The method gives rapid results, which can easily be interpreted in absolute units to give values of the " Chapman " constant for a mixture. A simple method of calibrating is included in the apparatus.

A demonstration, entitled *Some Simple Apparatus for the Estimation of Carbon Dioxide*, was given by Dr. Ezer Griffiths, of the National Physical Laboratory.

Apples respire, generating carbon dioxide. It has been found that the atmosphere of a gas-tight chamber gradually becomes richer in carbon dioxide and deficient in oxygen, and when the carbon-dioxide content exceeds a certain value the apples are liable to become diseased. The instruments demonstrated were devised so as to provide marine engineers with a simple means of making analyses of the atmosphere in the ship's holds carrying an apple cargo.

One was of the simple burette type, in which a measured volume of the gas under test is displaced into a potash tube and then returned to the burette for measurement after absorption of the carbon dioxide. Float valves are provided to prevent potash solution being accidentally drawn back into the burette or water swept over into the potash.

The novel feature of the second was a large hollow-barrel glass tap. Absorbent for carbon dioxide was packed into this hollow barrel. In one position of the tap a sample of gas was pumped through into a tube; in the second position the absorbent was in communication with the sample of gas resulting in an absorption of the carbon dioxide and consequent diminution of volume of the sample which was measured.

The third instrument was a large-bore tube bent into a nearly complete circle. This tube was mounted on an axis through the centre of the circle, so that it could be partially rotated. A large drop of mercury functioned as a piston for displacing the sample of gas contained in the tube through an absorbent cartridge. The diminution in pressure was indicated on a dial gauge calibrated to read in carbon-dioxide percentages.

The fourth instrument was a specially designed brass pump, by means of which a sample of gas is withdrawn from the ship's hold, and then displaced through an absorbent cartridge. As in the previous instrument, the carbon-dioxide content is indicated on a dial gauge.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

19,497.—Bashiloff, I.—Method of separating radium and barium salts. July 31st.

19,472.—Binz, A.—Production of heterocyclical arsenic-containing compounds. July 31st.

19,326.—Island, J. S.—Electric formation of oxides of nitrogen. July 30th.

19,578.—Steffen ,C.—Process for obtaining tricalcium saccharate. August 1st.

Abstract Published this Week.

235,368.—Subdividing glue, etc. — Akt.-Ges. Fur Chemische Produkte Vorm., H. Scheidemandel, 35, Dorotheenstrasse, Berlin, Sakom D., 13, Adolfsallee, Wiesbaden, and Askenasy P., 44, Kaiserallee, Karlsruhe, both in Germany.

Glue, gelatine, or the like is obtained in small beads or grains by passing its solution in the form of drops through a cooling agent comprising a liquid miscible with the colloid, or a gas or gaseous mixture, or a liquid immiscible with the colloid, the colloid in the last case being subsequently passed through a cleansin gliquid. As miscible cooling liquids water, aqueous solutions of salts, or aqueous emulsions may be used. In using a gaseous cooling agent, the drops of colloid may be caused to pass

in countercurrent to the gas or they may be sprayed into a container in which the gas is held under pressure. Suitable immiscible cooling liquids are benzol, benzine, trichlorethylene, tetrachlorethane, carbon bisulphide, and benzyl alcohol, and suitable cleansing liquids for use in conjunction therewith are water, aqueous solutions of salts, and aqueous emulsions. The cooling liquid, if lighter than the cleansing liquid, may be superposed thereon, the specific gravity of the cleansing liquid being, if desired, increased by the addition of soluble substances, but if the cooling liquid is the substances ,but if the cooling liquid is the heavier, the grains are collected and passed through a lighter cooling liquid superposed on a cleansing liquid.

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SYNTHOX.

459,201.—A chemical substance to be used in the purification of Gas.—A. Johnston and Partner, Abbey House, 10, Victoria Street, Westminster, London ,S.W.1. August 5th.

BITUMITE.

460,159.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—G. M. Callender and Co., Ltd., 25, Victoria Street, London, S.W.1. August 5th.

MERCURINHAL.

457,707.—Chemical substances prepared for use in medicine and pharmacy.—C. Engelbreth, Norrebrogade 82, Copenhagen, Denmark. August 5th.

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459,833.—Chemical substances prepared for use in medicine and pharmacy.—May and Baker, Ltd., Garden Wharf, Church Road, Battersea, London, S.W.1. August 5th.

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THE ELECTROLYSIS OF EQUIMOLAR MIXTURES.

By ROBERT SAXON, B.Sc. (Vict.)

The electrolysis of salts in equimolar proportions, without the addition of sulphuric acid, has suggested the following :—

(i) In the reactions, etc., a more electropositive ion displaces one less positive, *e.g.*, *zinc* displacing *copper*, or *sodium* ousting *zinc*. The apparatus used is of the usual type for the electrolysis of water, arrangement being made for collecting the evolved gases in upright tubes, removable for purposes of cleaning, and carrying an arbitrary scale for comparing rates of evolution of the gases.

(ii) As platinum is too costly to give adequate surface, substitutes have been tried. Carbon is satisfactory where Chlorine, or Hydrogen are given off, and is used in such cases. To obtain uniformity it is always used as cathode. As anode, ferro-chrome, ferro-tungsten (Messrs. Hadfields), ferro-silicon (Messrs. Firth's Staybright Steel, and Messrs. Meldrum's Acid Resisting Metal, as well as Tungsten supplied by the General Electric Company) have given most satisfactory results as regards resistance to disintegration. An anode of Meldrum's metal, weighing 108.175 grams after running 4 hours 25 minutes in water containing 6% pure H_2SO_4, 15% strong HCl, and 5% $K_2Cr_2O_7$, weighed 107.950 grams. With a mixed hot saturated solution of calcium chloride and bleaching powder, acidulated with nitric acid (with a view to obtain the chlorate) Firth's steel lost 0.903 grams from an original weight of 10.845 grams after running 65 hours. A rod of Hadfield's chrome steel used in the electroylsis of damp KOH as anode lost about 0.02% of its weight after running 49 hours. The cathode in this case was mercury, which amalgamates with the potassium.

When a mixture of gram molecular weights of zinc and copper sulphates, dissolved in one litre of water to each salt, is electrolysed, a blue-white flocculent gel is carried up the cathode tube. This has proved to be cupric hydrate slightly deficient in oxygen, but shewing no free copper. With concentrated solutions in molar proportions, copper is carried up the tube and also deposited round the cathode. There is little more than a trace of zinc hydrate even with rapid electrolysis using a potential of 27 volts got by putting three lamps in the lighting current as resistance. In every case there is evolved at the

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

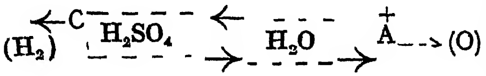
cathode, hydrogen and cupric hydrate.

A mixture of equivalent weights of sodium sulphate and zinc sulphate electrolysed either slowly or rapidly, concentrated or dilute, give only zinc hydrate, with no evidence of the formation of NaOH, the electrolyte being acid at the end.

Such a mixture of sodium and copper sulphates gives with greater dilution (1 mole. per 2 litres) copper hydrate only, and probably colloidal copper. Concentrated solutions and rapid electroylsis give copper, but the hydrate is always formed, and except where the temperature rises quickly (generally about 50 degrees in the hour) remains to the end, when there is no further blue cuprion in the electrolyte.

Evaporation of the electrolyte reveals the fact that in each case the sulphate of the more positive metal is left. It would seem that the ion carrying the stronger charge would be attracted by the cathode and then would displace not hydrogen but the heavier metal, which, acting upon the water, displaces hydrogen.

(iii) A symbolism has been adopted which does away with the necessity of indicating ion and anion, except in special cases. Thus, with the case of acidulated water, we give the reaction thus :—



The cathode attracts and discharges the hydrion, the anode A doing the same to the oxygen, and the hydrion of the water taking on the sulphanion of the sulphuric acid. We alyays write these symbols in these relative positions, placing the *more positive ion salt to the left* of the other, or the more negative anion SO_4 in that relative position. We place liquids in broken line rectangles, solids in unbroken line rectangles, and gases like liquids except for bulging ends. Movements of ion and anion are indicated by broken lines, as electrolysis depends upon liquidity, and that of atoms or unelectrified substance by unbroken line arrows. The cathode is always placed to the left and the anode to the right. We always understand that the positively charged ion proceeds towards the left, and the negatively charged anion towards the right. Looking at the discharged bodies beyond the arrows, we can see what are the ions and anions of the salts concerned. We may dispense with the these as sulphates in turn, the readiness also the metal, and lastly with copper the broken lines and represent the three experiments referred to above thus :—

I.

(a) $H_2 \leftarrow$ – 2HOH $CuSO_4$ $H_2O \dashrightarrow O$

$\downarrow$

CuO_2H_2

(b) $Cu \leftarrow$ $CuSO_4$ $H_2O \rightarrow O$

(The positive ion arrow is superior to that of the anion.)

II.

(a') $H_2 \longrightarrow$ 2HOH $\downarrow$ $CuSO_4$ $ZnSO_4 \dashrightarrow SO_3+O$

CuO_2H_2

(b) $Cu \leftarrow CuSO_4$ $ZnSO_4$ $> SO_3+O$

III. as II., substituting $NaSO_4$ for $ZnSO_4$

Thus, where we have the salts of metals far removed from each other on the electrochemical list, the less positive metal is deposited as hydrate. Where metals are close together on that list, such as copper and hydrogen, each seems capable of displacing the other according to circumstances. Equimolar mixtures of magnesium and zinc, aluminium and iron (ferric), nickel and copper, cobalt and nickel, sulphates, it is a mixture of the two hydrates which is deposited, as the two ions in each case are close together on the list, but it is the more negative one which appears first.

Note that ordinary arrows and + signs are used only outside electrolysis that is past the electrode, or as precipitate, or as newly ionized per salts $[Co_4(SO_4)_3]$ and the resultants of ionic "swinging" where the OH or SO_4 of the salt to the left takes up the ion on its right.

It would appear that both hydrates are sent down because of their insolubility, but magnesium and nickel sulphates give only the hydrate of nickel. With a mixture of copper and lead acetates the action is very feeble. Generally the rate of delivery of hydrogen varies with the conductivity, and with an arbitrary scale and a watch, such forms a rough measure of the latter. Near neighbours on the list give much more resistance than those far apart.

There is in the periodic arrangement of the elements an "Intrusive Stratum," V, Cr, Mn, Fe, Co, Ni, Cu showing a basic slope or fall in affinity for oxygen. Beginning with chromium and electrolysing a

mixture of potassium sulphate and each of these as sulphates in turn, the readiness with which $Cr(OH)_3$, $Mn(OH)_2$ and $Mn_2O_3H_2O$, green $Fe(OH)_2$ turning to brown $Fe_2O_3xH_2O$, an olive green mixture of $Co(OH)_2$ and $CoSO_4$ (which according to the text books should be *blue*), the solution turning brown ($Co_2(SO_4)_3$ Marshall) tiny ruby crystals of $Co(OH)_3$ and later brown $Co(OH)_3$ yielding black Co_2O_3 on heating, bright green nickelous hydrate and Ni_2O_3 also the metal, and lastly with copper the cupric hydrate and the metal are given off shows this " slope."

The behaviour of cobalt sulphate may be *diagramatically* represented thus :—

(a) $H_2 \leftarrow 2H.OH \quad Co.SO_4 \quad Na_2.$

$$Co.SO_4 \downarrow Co(OH)_2 \qquad Na_2. \downarrow Na_2SO_4$$

$$SO_4 \quad 2CoSO_4 \downarrow Co_2(SO_4)_3$$

(b) $3H \leftarrow 6H.OH \quad CO_2(SO_4)_3.$

$$\downarrow Co_2(OH)_6$$

$$3Na_2.SO_4 \rightarrow SO_3 + O$$

Here the ions and anions are shown separated by dots. The relative positions, and end products beyond the arrows, make it clear which is which. In all probability every component in an electrolyte acts in a catenary way, and as dissociation proceeds, ions release their anions and take up those of neighbouring ions. We always write the formula of a compound the order ion and anion, and a dot bteween suffices to say that the substances are ionized.

Mixtures of three salts in equivalent quantities give the hydrate of those metals above hydrogen in the electrochemical list, the lower ones first and those near these afterwards. Thus an "equivalent mixture" of sodium, aluminium, and ferric sulphates gives first ferric hydrate, and then aluminium hydrate, thus :—

Hydrogen	$6H \leftarrow$	$6H.OH$	$Fe_2(SO_4)_3$	$Al_2(SO_4)_3 \rightarrow SO+O$	Oxygen
Ferric Hydrate	$Fe_2(OH)_6 \leftarrow$				given off.
& Aluminium	$6H \leftarrow$				
Hydrate		$6H.OH$		$Al2.(SO_4)_3 \longrightarrow SO_3+C$	SO_3 unites with water.
given off.	$Al_2(OH)_6 \leftarrow$				

THE SYNTHESIS OF THE POLYACETIC ACIDS OF METHANE. PART I. THE CONDITIONS CONTROLLING THE SYNTHESIS BY THE CYANOACETIC ESTER METHOD, THE PREPARATION OF METHANETRIACETIC ACID AND SOME ABNORMAL CONDENSATIONS OF MALONIC AND CYANOACETIC ESTERS WITH HALOGENATED METHANES.

By R. F. Hunter.

The researches on the synthesis of the polyacetic acids of methane were undertaken at South Kensington at the suggestion of Prof. Thorpe, with the object of finding suitable methods for the preparation of large quantities of certain polyacetic acids of methane such as triacetic acid (1) the carboxytriacetic acid (2) and the tetra acetic acid (4), with a view to aiding the work on the spiro compounds which are still being studied in the research laboratories of the Royal College of Science, and it was shown by Professor Ingold, F.R.S., that these acids were very difficult to prepare owing to the failure of the standard methods of synthesis.

$CH(CH_2CO_2H)_3$ (1) $\qquad CO_2HC(CH_2CO_2H)_3$ (2)

$C(CH_2CO_2H)_4$ (3)

In a paper published by the author in this Journal some time ago (*Chem. News*, 1923, CXXVII.), the question of the mechanism of the cyanoacetic ester condensations was discussed, and it was shown that the great majority of these were referred to the direct addition of ethyl cyanoacetate to an unsaturated compound (*loc. cit.*) In view of this difficulty which one encounters

in the synthesis of the higher acids of this series by the cyanoacetic ester synthesis are given a rational explanation, for if one considers the unsaturated acids (4), (5) and (6) having in their composition one molecule of acetic acid less than the polyacetic acids referred to above, one sees at once that all the substances are of the mobile glutacomic acid type, that is to say, their permanent forms are not the unsaturated acids

$$CO_2HCH:CHCH_2CO_2 \quad (4)$$

$$CO_2HCH:C(CO_2H)CH_2CO_2H \quad (5)$$

$$CO_2HCH:C(CH_2CO_2H)_2 \quad (6)$$

The researches which have been carried out at South Kensington during the last ten years by Professors Ingold, Thorpe, and Dr. Kon have shown that such substances possess many peculiar properties, in their normal or what we might call permanent forms they are best represented by the symmetrical formulæ of the semi-aromatic type as hereunder.

$$CO_2HCHCH_2CHCO_2H \quad (7)$$

$$CO_2HCHCH(CO_2H)CHCO_2H \quad (8)$$

$$CO_2HCHCH(CH_2CO_2H)CHCO_2H \quad (9)$$

These substances, as will be seen, are by no means unsaturated and are therefore unreactive; however, they exist as we know in tautomeric equilibrium with their unstable unsaturated isomerides, and hence the possibility of obtaining the required condensation products depends on the relative stability of the phases and the velocity of tautomeric interchange. The conditions are well illustrated by the work of Thorpe and Wood on β-methylglutaconic acid (*Jour. Chem Soc*, 1913, 1579) and by Thorpe (*Jour. Chem. Soc.*, 1919), here we have extremely low velocity of tautomeric interchange, and the esters of the unsaturated modification of the acid can be kept in the dark for years without appreciable isomerisation.

With regard to the case of glutaconic ester, the tautomeric exchange is sufficiently rapid to render it impossible to isolate the two forms when it is allowed to react with ethyl sodiocyanoacetate.

The ester which can be isolated is the normal form, although there is a minute trace of the other present, necessary for the establishment of an equilibrium. The reaction tending to restore equilibrium when it is disturbed by the removal of the unsaturated ester appears to proceed with a fair velocity, and despite the low concentration of the substance, it is possible to isolate a condensation product directly derived from it, the yield under the most favourable conditions is ,however, small, when this condensation product is hydrolysed, the triacetic acid (1) is obtained, but as a method for preparing quantities of the substance for a research, the method was quite hopeless.

Ethyl aconitate, from which one might expect to obtain the acid (2) by condensation with ethyl cyanoacetate and hydrolysis of the condensation product is apparently a mixture of normal and labile for s in equilibrium, but with the important difference that owing to the presence of the carbethoxyl attached to the central sodium derivative of ethyl cyanoacetate. It is noteworthy that Auwers and his collaborators experienced no difficulty in oftaining condensation products with ethyl sodiomalonate. On hydrolysis they obtained three acids, two of which were modifications of n butane $\alpha\ \beta\ \gamma\ \delta$ tetra carboxylic acid, and the third, cyclopentane 3:4 dicarboxylic acid. The condensation must have taken place by way of the malonic ester residue having become attached to the alpha carbon atom of the aconitic molecule.

It was found, in the first place by Ingold and his collaborators, that the replacement of ethyl malonate by ethyl cyanoacetate not only improved the yield of condensation product, but greatly simplified the separation by fractional crystallisation of the three very soluble acids, which made by the method of Auwers are very difficult to separate. There were two condensation products, the normal cyano a ester (10) and an acid ester. These were easily separated by taking advantage of the solubility of the latter in sodium carbonate solution, the ester (10) on hydrolysis gave only one form of the n butant tetracarboxylic acid, whilst the acid ester yielded solely the ketonic acid, cyclopentanone 3:4 dicarboxylic acid.

$$CH_2(CO_2Et)CH(CO_2Et)CH(CO_2Et)—$$
$$—CHCNCO_2Et.$$
(10)

Now though one might expect the normal form of ethyl aconitate to yield via 1 :3 addition nothing but the ester (10) and its internal condensation product, it is not clear why the unsaturated isomeride should not to some extent condense to yield a product in which the cyanoacetic residue is attached to the central carbon atom of the aconitic skeleton, such a condensation product would yield the carboxytriacetic acid (2) on hydrolysis and repeated efforts were made by Professor C. K. Ingold to prepare the labile form of aconitic acetylcitrate (*Berichte*, 1885, 1983) and the esterification under the mildest conditions of labile aconitic acid were investigated, the results were in all cases failures.

The somewhat peculiar conditions which regulate the condensations of ethyl cyanoacetate with unsaturated compounds are still apparently the controlling factors when halogen compounds are used, thus when chloroform is condensed with cyanoacetic ester, the stable product is in each case a derivative of glutaconic acid, which refuses to take up another molecule of the additive reagent. The condensations with carbon tetrachloride instead of chloroform have been studied, but no investigator appears to have isolated even a trace of the tetra acetic acid (3). The condensation with ethyl tricarballylate might be expected to give a compound which on hydrolysis would give the acid (2) but here again the tendency towards glutaconic formation is so strong that the whole of the chloro ester appears to proceed to ethyl aconitate.

The obvious methods of synthesis fail then. Now in the paper on cyanoacetic ester condensation (*loc. cit.*) it was noted that ethyl sodiocyanoacetate condenses with the esters of hydroxy acids with great ease, and it was therefore hoped that ethyl β hydroxyglutarate would yield a condensation product (11) which on hydrolysis would give the triacetic acid (1) and that in a similar manner ethyl citrate would give rise to (12) which would hydrolyse to (2)

$$\begin{array}{l} CH_2CO_2Et \\ | \\ CHCH(CN)CO_2Et \\ | \\ CH_2CO_2Et \end{array}$$
(11)

$$\begin{array}{l} CH_2CO_2H \\ | \\ CHCH_2CO_2H \\ | \\ CH_2CO_2H \end{array}$$
(12)

Experiment justified this assumption as regards the first case and a 60% yield of acid (1) was obtained by Ingold. Ethyl citrate, however, gave a mixture of condensation products which, on hydrolysis gave n butane α β γ δ tetracarboxylic acid and cyclopentanone 3 :4 dicarboxylic acid, but no trace of the polyacetic acid (2).

The next question studied in this investigation was that of certain abnormal condensations of malonic and cyanoacetic esters with halogenated methanes.

The difficulty in condensing the esters of unsaturated acids with ethyl cyanoacetate is ascribed to the difficulty of obtaining the substances in a sufficiently stable condition owing to the tendency to pass into normal isomerides.

To obtain the required condensation product it is necessary to adopt special means of ensuring that the glutaconic derivative shall react in its labile unsaturated form, the method of bringing this about is usually to generate the appropriate labile glutaconic ester in the presence of ethyl sodiocyanoacetate and thus affect the combination when the unsaturated ester is in a nascent condition. This method has been applied to the preparation of methanetriacetic acid as indicated and there seemed no reason to suppose that the tetra acetic acid would not be produced in the same way if the unsaturated ester (13) could be employed in a nascent condition.

$$CO_2HCH_2C \lessgtr \begin{array}{l} CH_2CO_2H \\ CH_2CO_2H \end{array}$$
(13)

It seemed that this could be done by the allenetetracarboxylic ester of Zelinsky and Doroschewski which can readily be prepared from carbon tetreachloride and malonic ester (*Berichte* 1894, XXVII., 3374). This ester would react with ethyl cyanoacetate to form a derivative of the unsaturated acid, and whatever the changes of structure during the isolation, must in the first place be produced in the form in which two double bonds in the allene derivative are preserved, if the formation occured in the presence of ethyl sodiocyano

acetate, a further condensation would take place with the formation of (14) from which methanetethacetic acid could be obtained by hydrolysis.

$$\begin{matrix} (CO_2Et)_2CH \\ CO_2EtCHCN \end{matrix} > C < \begin{matrix} CH(CO_2Et)_2 \\ CH(CN)CO_2Et \end{matrix}$$

(14)

There seemed every reason for anticipating that the reaction would proceed smoothly, for in the first place Zelinsky and Doroschewsky had shown that allenetetracarboxylic ester is a substance having strong additive properties and in the second place the intermediate plutaconic derivative contains a number of alpha substituents, a condition which always confers stability on the unsaturated modification. It was surprising to find that the product of condensation contained no trace of the intermediate glutaconic derivative or of (14) or of other substances which might be derived from them. Ultimately, the reason was found by Ingold and Powell in the fact that the allenetetracarboxylic ester of Zelinsky and Doroschewsky was not an allene derivative and was not even a substance of the same chemical composition. The initial product of the Zelinsky reaction from carbon tetrachloride and ethyl sodiomalonate was a yellow sodium compound, and on treatment of this with dilute acid the sodium was replaced by hydrogen and there was produced an oily unsaturated ester which, on distillation, gave the crystalline ester by elimination of alcohol.

On repeating the experiments under the conditions described in the literature, Ingold and Powell found there was no difficulty in confirming the results, except with regards to the chemical characters of the substances isolated. ontrary to the suggestion of the earlier investigators, the yellow sodium compound proved not to be the ethoxy compound, but well-known substance which had previously been prepared by Conrad and Guthzeit (*Berichte*, 1882), by the condensation of chloroform and ethyl sodiomalonate. This gave the oily ester of Zelinsky, which is really ethyl dicarboxyglutaconate. This, on distillation, passes into the solid ester which they regarded as the allene derivative which is the well-known lactone. All these substances yielded glutaconic acid on hydrolysis and were further identified by comparison with specimens.

To obtain some information as to the mechanism of the change, the interaction of carbon tetrachloride and ethyl sodiocyanoacetate was investigated, if the condensation was normal, the product would be dicyanoallenedivarboxylic ester (15), on the other hand, if the carbon tetrachloride behaved as chloroform does, then it should be $\alpha\gamma$ dicyanoglutaconic ester (16), an easily isolated crystalline substance. Actually the product was dicyanaglutaconic ester showing that the tetrachloride reacted in the same way as chloroform.

$$CO_2EtCNC:C:C(CN)CO_2Et$$

(15)

$$CO_2Et(CN)CHCH:C(CN)CO_2Et$$

(16)

In the course of this reaction a large amount of cyanoacetamide was always produced. This at first sight seems rather extraordinary. The difficulty was, however, to a large extent removed when it was found that along with the cyanoacetamide there was present α-cyano β-imino glutarate, a substance originally prepared by Best and Thorpe by the condensation of ethyl cyanoacetate with its sodium derivative. Clearly then ethyl cyanoacetate must have been liberated during the condensation and this must have combined with some unchanged sodio derivative, with the production of ethyl α-cyano β-iminoglutarate from which the free cyanoimino ester would no doubt be produced. The imino derivative must then have undergone fission at the double bond after having been transformed into its aminoglutaconic modification ethyl cyano malonamate being formed, which, in the presence of hot sodium ethoxide would break down into ethyl carbonate and cyanoacetamide.

The apparent impossibility of having a normal condensation with carbon tetrachloried and ethyl sodiocyanoacetate is of significance in view with the fact that trichloracetic ester yields no condensation product with either ethyl sodiocyanoacetate or ethyl sodiomalonate under the usual experimental conditions, for it would seem to follo wthat no halogenated derivative of methane can react normally with such sodio esters unless at least one hydrogen atom is attached to the carbon. If this is the case, then doubtless no more than a phase of the general law that the production of a con-

dition of unsaturation in these cases involving bivalent carbon is necessary to all organic rseactions.

To test the matter further, the behaviour of ethyl sodio cyanoacetate and ethyl sodiomalonate towards two other halogenated methanes was studied. The substances chosen were carbon tetrabromide and chloropicrin, and the results were in harmony with the general hypothesis, for in neither case could a trace of the normal condensation product be isolated.

Highbury New Park, N.5.

October, 1923; Revised, June, 1924.

A NOTE ON THE PRECIPITATION OF BISMUTH TRISULPHIDE FROM ACID MEDIUM.

By S. Ramachandran.

This investigation suggested itself to me when, during a course of lectures being delivered by me to my students I found to my dismay that bismuth could not be precipitated from a strongly acid solution of bismuth chloride, although several textbooks state that bismuth is precipitated as sulphide by sulphuretted hydrogen, even in acid solution, and that bismuth sulphide is soluble in concentrated hydrochloric acid only on long continued boiling (*vide* Treadwell, *Analytical Chemistry*, Vol. I., page 192, 1915 edition; and J. R. Partington's *Text Book of Inorganic Chemistry*, 1921 edition, page 943.)

Experimental.

(1) A solution of about .5 gram of bismuth trioxide was prepared in 5 cc. of warm concentrated hydrochloric acid and the clear solution set aside to cool. A current of sulphuretted hydrogen was passed through the solution when no precipitation was observed. 5 cc. of distilled water were added and the process repeated, but with the same result. The addition of measured quantities of water was continued till it was found that a certain stage the solution grew faintly coloured brown, indicating thereby the beginning of precipitation. Further quantities of water had to be added before the precipitation was complete. Precipitation commenced when the proportion of concentrated acid to water was about 1 :3 and was complete when it was about 1 :5.

(2) Pure bismuth trisulphide was obtained by precipitation and successive washing until free from impurities. On adding cold concentrated hydrochloric acid to the product it was found that it readily dissolved, with evolution of sulphuretted hydrogen. At our laboratory temperature (about 30 degrees C.) even when the concentration of the acid was 1 of acid to 3 of water, the solubility of the compound was nearly complete.

Conclusion.

This experiment, simple as it is, raises several interesting questions, which it is my intention to attack by and by. For example, it might be interesting to enquire (1) into the effect of temperature on the solubility of bismuth trisulphide in hydrochloric acid; (2) into the effect of using bismuth trisulphide kept in contact with the liquid from which it was precipitated; (3) into the exact composition of the precipitate obtained, and so on.

S. Ramachandran.

The Chemical Laboratory,
Ceded Districts College,
Anantapur, Madras Presidency.
16 July, 1925.

ACTIVATED CARBON.

(From a Correspondent.)

One of the most remarkable developments in chemical technology is the manufacture and application of activated carbon. As is well known, of course, ordinary charcoal, and especially bone black, possesses considerable properties of absorbing gases, decolourising liquids, and promoting chemical reactions, and activated carbon is a peculiar and remarkable form in which these properties are enormously developed as compared with bone black or any other form of carbon. It would appear to be a modification of the element carbon in which the pores are not only of almost incredible smallness in size, but have also entirely porous walls and are not clogged up with impurities, so that the chemical reactivity of the material and the promotion of "surface action" is improved to a remarkable degree.

According to this theory, carbon would seem to exist in two entirely separate modifications, active, and inactive, the proportions of which in any form of carbon are largely dependent on the temperature at

which it is formed. Thus ordinary charcoals or bone blacks, whilst mostly composed of ordinary inactive carbon, also contain a certain proportion of the active variety.

One of the best known firms in Great Britain in this field are Messrs. Sutcliffe Speakman and Co., Ltd., of Leigh, Lancs., who supplied large quantities of activated carbon for gas masks during the war, and they have available a complete range of different qualities.

The uses of the material in the industrial fields are so numerous that it is impossible to even give a list of them, but in the first place with regard to decolourising liquids, it is used for cane sugar, glucose, and brewing sugars, such as maltose and lactose. The possibilities in this connection are very great, not only in refineries as a much more efficient substitute for animal charcoal, but also for use direct on the sugar plantations, to reduce the amount of off-grade sugar now turned out. Other typical applications to liquids are vinegar, cream of tartar, citric acid, lactic acid, alcohol, alkaloids, photographic chemicals, and organic compounds used in dyestuff manufacture, together also for the extraction of gold from excessively dilute solutions in the cyanide process. Further, a very important section of this work is in the purification of oils and fats, such as tallow, cocoanut oil, linseed, peanut and corn oil, cotton seed oil and castor oil. For example, to take one case only, in the purification of cocoanut oil, Fuller's earth is at present used, but activated carbon gives far superior results, and the same applies to castor oil.

In applying the treatment, activated carbon is, as a rule, simply stirred up with the heated liquid for a short period and then blown through filter presses, the process being subsequently revived by various methods after acting for a number of times. Thus it may be boiled with water, re-burnt, or treated with acids or alkalies, although in some cases this is not worth while when the liquid is only slightly coloured and the carbon lasts a very long time.

Then again, an important field for activated carbons is catalysis, of which a case in point is the manufacture of sulphur dichloride from sulphur monochloride by the action of chlorine in the presence of activated carbon.

Finally, a very important field is in the extraction and purification of gases, such as the direct separation of motor spirit from the crude gases evolved in the carbonisation of coal and other carbonaceous material.

STEAM GENERATION EFFICIENCY.

A Striking New Device.

By A Well-Known Engineer.

New and improved appliances for the more efficient generation of steam, especially as applied to water tube boilers, continue to make their appearance, and decidedly one of the most striking of these is the "Murray" water-cooled combustion chamber wall. This can be applied equally well to pulverised fuel, mechanical stoker, gas, and liquid fuel firing, also in conjunction with one another in any desired combination, whilst, further, it should be of value for the utilisation of waste heat. Up to the present, however, the invention has enabled mechanical stoking to obtain the remarkable efficiency results 92%, or even over, on day tests, and nearly 90% on continuous running, equal to the latest principles of pulverised fuel firing.

The invention consists essentially in building up the two side walls of the combustion chamber of a series of vertical 4″ steel tubes placed close together through which the boiler feed-water circulates at the full boiler pressure, entering through a common header at the bottom, and being discharged through a corresponding header at the top direct into the boiler, resulting in a great increase of the nett heating surface of the boiler, specially valuable because it it next to the actual combustion space, giving much increased radiant heat transmission. The "Murray" tubes were fitted over 12 months ago at the Hell Gate power station of the New York Edison Co., Thomas E. Murray, the inventor, being the designer of this station, on four very large boilers of 150,000 lbs. normal evaporation, and the world patents are now controlled by the Combustion Engineering Corporation of New York, whilst the European rights are held by the Underfeed Stoker Co. Ltd., of London. The results at Hell Gate have been so remarkable, as already indicated, that they constitute a revolution in mechanical stoker firing.

As regards constructional details, the 4″ tubes are of solid drawn steel, placed side by side at 7″ centres, and down each side are electric welded ¼″ steel flanges or fins, one of which projects 1¾″ and the other 2¾″ from the tube surface. These fins overlap one another, a long and a short one always being in contact, in such a manner that the whole surface of the wall is built up of 4″ water-cooled steel tubes with 3″ of overlapping steel between. The bottom part of

the furnace wall for a few feet is, however, built of solid firebrick, and behind the steel tubes for the full height is 2½″ thickness of some insulating material, and 2½″ of brick, followed by the casing of the boiler plant, this outer wall being merely to prevent air leakage.

A further advantage claimed for the tubes is that they cause a substantial reduction in the wear and tear on the brickwork setting at the back, since the radiant heat is absorbed so quickly by the water and on the very large boilers mentioned this figure alone is stated to be over £1,000 per annum, whilst they show no sign of damage after 12 months' continuous running.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES.

By J. P. Dunlop.

Mine Production.

The total value of the gold, silver, copper lead, and zinc mined in the Eastern States in 1924 showed an increase of 10 per cent. from the corresponding value in 1923. Of the total value, gold represented $16,535; silver, $65,411; copper, $2,547,993; lead, $353,920; and zinc, $16,875,606. The increase was caused almost entirely by the larger output of zinc and lead, as the production of gold continued small and that of copper and silver was substantially less in 1924 than in 1923.

Gold and Silver.

Of the mine output of gold in 1923 placers yielded only $193, the smallest yield for many years, siliceous ores $5,118, and copper and magnetite ores $11,224.

The deep and places gold mines, which have produced nearly all the gold in the Eastern States, supplied only 32 per cent. in 1924, and of these one deep mine produced more gold than the other six deep and placer mines combined. The output of siliceous ore increased considerably, though only one mill was operated on ore derived other than incidentally from development work. Not only were fewer gold mines, both placer and deep, operated in 1924, but less development work was accomplished than usual. Lack of available capital hampered the working of many properties, and scarcity of labour, high costs, and low-grade ore were contributing reasons for the almost total cessation of active gold mining in many districts in the South.

The gold obtained in refining copper bullion from Tennessee and Pennsylvania has been the only uninterrupted source of gold in the Eastern States in the last six years.

Copper.

The mine production of copper in the Eastern States in 1924 was valued at $2,547,993, a decrease of $463,654. The entire output was derived from Tennessee copper ore and from Pennsylvania pyritiferous magnetite ore.

The quantity of ore treated to produce this copper was 1,399,675 short tons. Exclusive of the magnetite ore, which was mined for its iron content and contained very little copper, the average yield of copper from copper ore was approximately 1.28 per cent., or 25.6 pounds to the ton, and this copper ore also yielded $0.098 in gold and silver to the ton.

The copper concentrates from the magnetite ore contained about 3.83 per cent. of copper and a small quantity of gold and silver.

Copper ore directly smelted amounted to 410,236 tons, from which about 11,240,587 pounds of copper was recovered. Copper and magnetite ore concentrated amounted to 989,439 tons, which yielded 49,242 tons of concentrates containing 8,209,742 pounds of copper.

Lead.

The only shipments of lead reported to the Survey were made by mines in Tennessee and Virginia, though it is stated that a few tons of lead ore was mined at the old Chipman mine, in Massachutetts, and was treated at a small smelter owned by the mine operators.

Zinc.

The recoverable zinc in the ore mined in the Eastern States in 1924 was valued at $16,875,606, an increase of $2,109,721. Zinc ore mined in New Jersey, Tennessee, and New York amounted to 1,874,759 tons —610,944 tons from New York. All the zinc ore from New York and Tennessee was sent to concentrating plants, and of the zinc ore from New Jersey, 553,701 tons was concentrated and the remainder was shipped as crude ore. In Virginia 70,709 tons of lead-zinc ore was concentrated, yielding both lead and zinc concentrates, which were shipped to smelters. The recoverable quantity of zinc from New York in 1924 was 9,328,000 pounds; from Tennessee 28,752,000 pounds; and from Virginia 5,328,000 pounds.

General Notes.

THE SMOKE NUISANCE.

Planning the Winter's Campaign.

The ever-increasing interest in the problem of securing a purer atmosphere with its resulting benefits, will receive a further impetus from the Smoke Abatement Conference to be held at the Palace Hotel, Buxton, in the autumn. This meeting, which is in the form of a Smoke Week-end from Friday evening, October 2, to Monday morning, October 5, is being arranged by the Smoke Abatement League of Great Britain, and judging by the support promised from many influential quarters, should be a most important event.

Certain practical proposals for reducing both domestic and industrial smoke are being prepared by the League for full consideration by those attending, and prominent individuals have agreed to open the discussion at the various sessions. It is hoped that a constructive programme of useful work will be initiated, the results of which can be reviewed at the Smoke Abatement Exhibition and Conference at Birmingham in 1926.

The headquarters of the Smoke Abatement League are at 33, Blackfriars Street, Manchester.

CANADIAN PULP AND PAPER.

The total value of pulpwood produced in Canada last year showed an increase of 1.2 per cent. over the previous year, but the total value of pulp produced decreased by 8.8 per cent. On the other hand, the value of paper produced increased by 4.1 per cent. If the net value of production for the entire industry be considered as the sum of the values of pulpwood exported, pulp exported and paper manufactured, then the total for 1924 was $187,174,703, as compared with $188,642,109 for 1923 and $158,483,377 in 1922. The maximum, which was reached in 1920, *viz.*, $224,414,131, was followed by a decided decline in 1921 ($154,641,077), but, as will be seen, the figures for 1922 and 1923 show increases. The small decrease in 1924 is due to a falling off in value in the exportation of raw pulpwood and declines in the manufacture and exportation of pulp. The manufacture and exportation of paper both show satisfactory increases.

There were 115 mills in operation in Canada in 1924, as compared with 110 in 1923. Of these mills, 46 manufactured pulp only, 34 were combined pulp and paper mills, and 35 manufactured paper only. The 80 mills manufacturing pulp produced 2,465,011 tons of this material.

MACHINE THAT MAKES METAL TYPE UNNECCESSARY.

Public attention has recently been drawn to a remarkable invention which, it is claimed by experts, will revolutinise principles of printing that have been in use since Caxton's time, 450 years ago.

In effect, this new machine does away with metal type by substituting for it a photographic film upon which letters, figures, etc., have been photographed.

By means of a key-board, operated like a typewriter, letters and characters from a "master film" are projected, one by one, in rapid sequence on to a sensitised photographic film-base, and photographed, the "exposure" being made in a fraction of a second.

WIRELESS EXHIBITION AT MOSCOW.

With regard to the Wireless Exhibition now being held at Moscow under the auspices of the Commissariat for Post and Telegraph, the Leningrad Low Voltage Trust, the Nijni-Novgorod Wireless Laboratory and other interested bodies, the British Commercial Secretary at Moscow informs the Department of Overseas Trade that special conditions have been conceded by the Commissariat for Foreign Trade to induce foreign firms to import, exhibit, demonstrate and sell direct wares.

The exhibits cover the whole field of wireless, and include a good selection of articles manufactured by the Low Voltage Trust, as well as showing the extent to which the Nijni-Novgorod Laboratory has developed research work. The concessions are being made with a view to stimulating interest and enabling Soviet concerns and the public to become acquainted with developments and manufactured abroad.

IGNITION OF FIRE DAMP.

SAFETY IN MINES RESEARCH BOARD PAPERS.

Papers on "The Ignition of Firedamp," by H. F. Coward and R. V. Wheeler, and "The Lag on Ignition of Firedamp," by C. A. Naylor and R. V. Wheeler (Safety in Mines Research Board Papers Nos. 8 and 9), have just been published by H.M. Stationery Office (Price 6d. each net.).

There is an intimate connection between the subject-matter of these two reports, and they should be read in conjunction. The first constitutes a concise and practical summary of the objectives of research on the ignition of firedamp with reference to the requirements of the coal mining industry, and the results so far attained. The objectives are (1) to ascertain the conditions under which firedamp will ignite in order that means may be taken to avoid the occurence of such conditions in the pit, and (2) to ascertain which are the most readily ignited mixtures of firedamp and air, in order that these mixtures may be used when determining the liability of colliery equipment, such as flame and electric lamps, electrical apparatus generally, and explosives, to ignite firedamp.

Lag on ignition has an important bearing on safety in coal mines. It accounts for the fact that it is very difficult, if not impossible, to cause an external ignition of firedamp by the gauze of a miner's flame safety lamp heated by firedamp burning within it; and it provides grounds for the hope that it may be possible to compound explosives, the flames from which, being of exceedingly short duration, could not ignite firedamp, despite their high temperature. The second report deals more particularly with the results obtained by studying as fully as possible the phenomena accompanying the lag on ignition of firedamp, but as a necessary aid to the interpretation of these results the behaviour of other and dissimilar gases has been studied also.

GERMAN ALUMINIUM SHEET SYNDICATE.

The British Commercial Secretary at Cologne states that, according to the *Deutsche Bergwerks Zeitung*, negotiations have been opened by German aluminium rolling works with a view to establishing a syndicate which shall regulate the production and sale of aluminium sheets. A syndicate agreement has already been drawn up and agreed upon in its main points by the works participating. On the other hand, no agreement has so far been allotted to the various works in regard to output and sales, and it is expected that the negotiations will be somewhat lengthy.

CANADA'S MINERAL INDUSTRIES AND RELATED MANUFACTURES.

The High Commissioner for Canada has received from the Dominion Bureau of Statistics, a preliminary report for the year 1924, showing that Canada's mineral industries and the manufacturing industries dependent thereon, numbering 10,719 plants in all, last year represented an actual money investment of 1,550 million dollars as compared with a reported investment of 1,531 million dollars in the preceding year. Included in this sum were the cost of lands, buildings and plant equipment, the cost of materials and products on hand, and the actual working capital of the companies reporting. These industries employed on the average 196,888 persons, to whom salaries and wages amounting to $248,297,514 were paid. Production determined as sales was valued at $875,087,628, or about 75 million dollars less than in 1923. Metal mining showed an increase in production of about 17 million dollars; smelter outputs were up 1.2 million dollars; and manufactures of the non-ferrous metals rose 7.6 million dollars. On the other hand labour troubles in the coal mining industry reduced the output to a value of 54.5 million dollars, or 17.1 million dollars below the total for the previous year; the general depression in the iron and steel industry caused sales to decline to $308,476,650, a drop of 74.9 million dollars from the total in 1923.

IN LIGHTER VEIN.

M. Elizabeth Farson, Principal of Hamilton School, Cornelia Street, Chicago, sends us a leaflet containing the efforts of some of the pupils in the realms of science, from which we give a selection. The leaflets are, we are told, the result of real endeavour to foster latent imaginative thought and poetic expression among the pupils, to give the young students scientific experience and to stimulate mind movement through comparison and symbolism and to bring out sympathetically and artistically the many and varied vital experiences of childhood :—

Franklin— *Russell Pearson.*
Wild horse trainer
Lassoing Pegasus, Lightning.
Electricity— *Howard Dobin.*
"The Charge of the Light Brigade"
At Periodic Town.
Chemistry— *Florence Grabowsky.*
Mysterious puzzle book
Keeping scientists busy.
Copper— *Josephine Naylor.*
Cinderella in a green dress
Sitting in the gray cinders.
Eclipse— *Lorraine Spahn.*
Hamilton School children's dream
Shattered to pieces by hazy draperies
Electrons— *Harriet Cardosi.*
Champion ice skaters
Circling atomic pond at full speed.
Hydrogen— *Edwin McQueen.*
"Man Without a Country,"
Nolan of the City of Elements.
Oxygen— *Frank J. Thau.*
King of the atmosphere
Dwelling there with Queen Nitrogen.
Sun— *Gladys Dundore.*
Gold ballroom glittering with diamonds
Blinding to behold.
Eclipse in Chicago— *Anna Kettnich.*
Most marvellous movie, but—
Mother Nature forgetting to lift curtain.
Iron— *Robert Mann.*
A silvery white underground princess
Blushing every time she meets Oxygen.
Helium— *Arthur Frick.*
Hydrogen's younger brother
Promoted over him—"Safety First."
X-ray— *Wade Heritage.*
Reformed Munchausen of Periodic Town
Telling strange true tales.

and so on.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, March 20, 1925.

Soaps and the Theory of Colloids, by J. W. McBain, D.Sc., F.R.S., Professor of Physical Chemistry, University of Bristol.

The subject of colloids has suffered from an excess of conflicting speculations in the absence of precise and definite experimental evidence. It is still found difficult to devise methods of experiment which will yield results which are exact and also unambiguous.

At the time when we began work in this field, one of the chief recognised characteristics of colloids was their changeability and the dependence of their behaviour upon the vagaries of individual specimens. Our object was thoroughly to study one typical colloid in order to supply the definite evidence required for testing or building up the theory of the subject. No general theory can be true which is incompatible with carefully-established experimental evidence obtained with any one typical material.

Our chief experience is that the more carefully the colloid is studied the less colloidal it is found to be.

Soap is a unique material for the investigation of colloidal phenomena, because it illustrates nearly all the behaviour found in other colloidal systems, and is one of the few common reversible colloids which have a definite, simple, known chemical formula. Last, and most important, all results with soap solutions are quantitatively reproducible, and, in the many cases where our results have been tested in other laboratories, the experimental data have always been confirmed. We have been able to find one precise relationship after another; so that the results are almost lifted out of the colloidal field. Nevertheless, it remains true that soaps are typical colloids, and that the results are of general significance in determining the behaviour of colloids and their relationship to other states.

Soaps exhibit an apparently inexhaustible variety of behaviour, and few days pass without our making some new and interesting observation. A great deal of incidental information is obtained in our quest. For example, under certain conditions twice as much soap is required for a given amount of detergent action if the soap solution is allowed to stand for a day before use. Again, Miss Laing has carried out analyses which show that the substance which accumulates in the surface of soap solutions and of soap films is not free fatty acid, but a mixture of acid sodium soap with neutral sodium soap, a very slight excess of alkalinity in the soap solution converting it all to neutral sodium or potassium soap.

Soap is important as a type of a great class of substances known as colloidal electrolytes. It is essential carefully to examine the evidence obtained by a study of ordinary solutions of soap, since from it follows directly a proof of the micellar theory. The essence of the micellar theory

is that not the chemical molecules but aggregates of particles are the colloidal units.

It is necessary to show that hydrolysis, although always present to a slight extent, does not account for the major properties of the solutions. There are only traces of free fatty acid present, and there is but little free alkali, far less than in sodium carbonate; this has been shown by half-a-dozen independent quantitative methods. Hydrolysis is only of importance in dilute solutions. This is borne out by the fact that the hydrogen soap, cetyl sulphonic acid, has properties exactly parallel to ordinary soap in concentrated solution. Hence, the major properties of a strong soap solution are due to the soap itself.

We have found that in dilute solution soaps are ordinary crystalloids just like common salt, and dissociate into sodium and potassium ione and fatty ions. Upon concentrating the solutions, however, the undissociated soap molecules aggregate to form large particles of neutral soap—that is, neutral micelles. Likewise, the fatty ions unite in small groups to form a new type of particle—the ionic micelle—in which there is one free charge for each fatty ion. By changing the concentration or the temperature all intermediate proportions of these constituents can be produced.

Long ago Selmi and Nageli emphasised that not the chemical molecules but larger aggregates were the colloidal units out of which all larger structures are made. Nägeli in 1859 coined the word "micell" from *mica* (a crumb) in order to have a term with no presupposition of crystal or any other particular structure. Many years of study of starch convinced him that the micelles of which these granules are composed are essentially crystalline, and now the X-ray work of Debye and Scherrer and Sponsler has shown that this is correct for such colloids as gold sols and wood.

In the case of soaps there is no direct evidence of crystalline structure of the individual micelle, but Nägeli would have approved of the name micelle for the ordered arrangements based upon conceptions of polarity which since 1912 have become fashionable. The particles of neutral micelle in soap are found to range from a few hundred to thousands of Angstrom units in diameter depeding upon the soap and the conditions. These neutral micelles may be visualised by borrowing and modifying a suggestion of S. E. Sheppard (*Nature*, 1921, CVII., 73). Each particle is like a pair of military hair brushes, in which the bristles represent the hydrocarbon chains of the molecules arranged parallel to each other in sheets; two such layers being put together hydrocarbon to hydrocarbon. The two backs of the brushes on the outside represent the hydrate layer and the un-ionised electric double layer. A general survey of the facts with regard to the electrical double layers (*Jour. Phys. Chem.*, 1924, XXVIII., 706) has shown that only a minute fraction of such a surface can ionise—hence the name "neutral micelle." Such a micelle would owe its stability to its internal polar arrangement of the molecules and to the external heavy hydration of the sodium and carboxyl group. The explanation of the stability of colloidal particles should be extended to the discussion of suspensoid particles where it is usually ascribed to the free electrical charges. The present conception would explain the stability by the hydration or solvation conditioned by even an undissociated double layer, and at its maximum in the neighbourhood of uncompensated electrical charges. The principle here involved is the commonplace that like dissolves like, and that a particle remains in solution when it is completely surrounded or coated with chemical groups similar to those of the solvent.

The ionic micelle is more novel and is essentially different. It may be visualised by borrowing and altering a suggestion put forward by Reychler in 1914 for particles of soap, and more recently by N. K. Adam. It resembles a group of, say, less than a dozen eels tied together by the tails, and pointing outwards in all directions from the common centre. Each eel is a fatty ion with the charged carboxl group outwards. These carboxyl groups also are probably hydrated. Such an ionic micelle cannot grow large because the electrostatic repulsion would increase as the square of the electrical charges. The diameter of the ionic micelle as measured is only a few score Angstrom units. Many experiments on migration in an electric field have shown that the ionic and neutral micelles exist and move quite independently of each other.

The Indian Medical Record (Calcutta), devotes virtually all its July issue to tuberculosis, the subject being dealt with from various standpoints by a number of prominent Indian medical men, including an exhaustive article by the editor, Santosh Kumar Mukherji, M.B.

MICA.

By B. H. Stoddard.
(U.S.A. Geological Survey.)

Production.

The domestic mica industry in 1923 showed substantial increases over 1922 in quantity and value of both sheet and scrap mica sold by producers during the year, the total quantity of sheet mica sold being 2,063,179 pounds (1.032 short tons), valued at $311,180, and of scrap mica (which includes some derived from mica schist) 8,051 short tons, valued at $129,695. The total quantity and value of all mica sold represents increases of 27 and 43 per cent., respectively. Sales of sheet mica showed increases of 91 per cent. in quantity and 60 per cent. in value. Scrap mica, the quantity of which was the largest ever recorded, showed increases over 1922 of 21 per cent. in quantity and 14 per cent. in value. The average value of sheet mica was 15 cents a pound, against 18 cents in 1922, and the average value of scrap mica was $16 a short ton, against $17 in 1922. North Carolina and New Hampshire reported 95 per cent. of the total quantity of sheet mica and 76 per cent. of the scrap mica sold in 1923.

The sales were made by producers in 11 States—North Carolina, New Hampshire, New Mexico, Virginia, South Dakota, Wyoming, Georgia, Colorado, Connecticut, South Carolina, and New York, named in order of total quantity of mica sold.

Classification of Mica.

Mica is valuable in sheet form and as scrap suitable for grinding into a powder. For commercial sheet mica the individual pieces must be large enough to contain a rectangular area measuring at least 1½ by 2 inches, which must split easily and evenly and be nearly free from "cracks," "rulings," "markings," and all fracture lines and reasonably free from inclusions or specks of foreign mineral matter. The size stated is the smallest rectangular size that is saleable in the form of uncut sheet; the irregularly bounded rough-trimmed mica sheet must be nearly twice as large to yield this size—in other words, a sheet that would yield a suitable rectangle 1½ by 2 inches and would be classed at "1½ by 2 inches," would have to measure nearly 3 by 4 inches.

Splittings are the thin films or flakes of mica that are split from the smaller sheet or waste material. They are about one thousandth of an inch thick and are irregular in shape.

Material suitable as scrap for grinding must be free from all foreign matter, especially gritty material, such as quartz and feldspar.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

19,924.—Allen-Liversidge, Ltd.,—Means for conveying, etc., calcium carbide. August 7th.

19,838.—Damiens, A. A. L. J.—Process for separating carbon monoxide from industrial gases. August 6th.

19,808.—Ensoll, R.—Recovery of hydrochloric acid from ferrous chloride solutions. August 6th.

19,881.—Parkes, D. W., Removal of tar acids from ammonia liquor. August 7th.

Specifications Published this Week.

237,302.—British Celanese, Ltd., & Bader, W.—Manufacture of acetic andride and acetic acid.

214,221.—Standard Development Co.—Process of making metallo-organic compounds.

237,375.—Society of Chemical Industry in Basle.—Manufacture of dyestuffs.

237,394.—Synthetic Ammonia & Nitrates, Ltd.—Catalysts for synthesis of ammonia.

Abstract Published this Week.

235,727.—Cellulose acetate; acetic acid.—Vereinigte Glanzstoff-Fabriken Akt.-Ges., Elberfeld, & Paschke, F., Oberbruch, Kreis, Heinsberg, both in Germany.

Acetic acid is recovered from solutions of cellulose acetate in this solvent, with simultaneous separation in bulk of the acetate, by mixing the solution with an equal volume of a saturated salt solution so as to form a jelly, which is then gently pressed to separate a liquid containing a high percentage of acetic acid; the jelly is then moistened with the salt solution whereby

it is again swollen, and it is then pressed as before, a further quantity of acid liquid separating; for the final pressings, the jelly is moistened with water. Solutions of sodium or potassium acetate (and magnesium sulphate) may be employed; and the pressure may be applied positively or by centrifuging.

Messrs. Rayner and Co., will obtain printed copies of the Published Specifications only, and forward on post free for the price of 1/6 each.

The Latest TRADE MARKS

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LIGHTNING.

459,726.—A chemical solution for use in batteries and accumulators.—Louis Frederick Ducker, 55, Worple Road, Wimbledon, London, S.W.19. August 12th, 1925.

FERTILITE.

B455,133.—A fertiliser.—The Worcestershire Fertilizer Co., Ltd., Canal Works, Hanbury Road, Stoke Prior, near Bromsgrove, Worcestershire. August 12th, 1925.

CIMESTOL.

459,361.—Insecticides.—Samuel Hodgson Eastburn, trading as Samuel H. Eastburn & Co., 164, Queen's Road, Gorton, Manchester. August 12th, 1925.

CIBRONS.

460,075.—Chemical substances prepared for use in medicine and pharmacy.—Vitmar, Ltd., 49, Old Bond St., London, W.1. August 12th, 1925.

The above Marks have been "accepted" by H.M. Patent Office, and unless any objection is lodged, the Marks will be duly Registered. They are, however, officially advertised for opposition, which must be lodged within one month from date quoted. All particulars and forms for opposition will be sent free by Messrs. Rayner and Co., 5, Chancery Lane, London.

Publisher's Announcements.

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

THE STRUCTURE OF ZINC.

By HAWKSWORTH COLLINS, B.A. (Camb.).

In the *Chemical News*, 1920, CXXI., 220, the constitution of an atom of Zn was given as KCN for the following four reasons :—

(1) Zn(65) = K(39) + C(12) + N(14).
(2) The chemical properties of Zn and KCN are similar in several ways.
(3) The evidence of mineralogy is that the ultimate matrix of Zn is a zinciferous clay, such as occurs at Friedensville in considerable abundance with calamite, an oxide of Zn and Si. Seamon (Dana) says that the calamine has been gradually crystallised out of the zinciferous clays, *these having been first formed.* The inference that is made here is that the clay became zinciferous because the element Zn was first created by some means in or on this clay.

Apropos of this, zinc is found in the ashes of the yellow pansy growing in Rhenish Prussia in soil which contains that element. This has been recorded as an especially noticeable fact, and since it exactly represents a state of affairs that was suspected of being the cause of a soil becoming zinciferous, it is inferred not that the plant happens to be growing luxuriantly in this position because it found zinc there, but that the power of vegetable life has atomised the KCN in the plant and thus produced in the soil a deposit of zinc, the accumulation of ages.

Of course, a plant is a wonderful entity which finds its food in the small portion of soil which its roots can reach and in the substances which it can extract from the air by means of heat, light and electricity. It thereby produces its own complicated structure, and also the colour, scent and honey of its flowers to attract insects. In doing all this, there is no reason why one particular variety of plant should not have the additional power of bringing the three elements, K, C, and N, into such necessary juxtaposition as to form the element Zn with the assistance of heat, light, and electricity.

(4) As K is a monad and CN also a monad, the element when formed, would be a dyad; for atomisation in this theory denotes the union of monads by means of bonds which are not chemically evident, the valences generally being free to act. For instance, Si (= Na - H - H_3 - H) is formed by the union of four monads, and therefore has four valences.

The above structure for an atom of zinc will now be proved to be correct quite in-

dependently by means of the laws of relative volume and heat of formation.

This (and all other similar proofs which have appeared in the *Chemical News*) is an arrangement of *facts* in such a manner as to make plain the truths which underlie those facts. There is no hypothesis or guesswork in any part of the proof; in fact, it is evident that no hypothesis is possible in such matters, for no one could possibly foresee what the facts would make evident.

Lord Kelvin said: "When you can measure what you are speaking about and express it in numbers, you know something about it."

TABLE I.

	Zn	=	K	+	C	+	N
(5)	9.03	=	7.49	+	0.71	+	0.83
(6)	11.76	=	7.49	+	3.44	+	0.83
(7)	14.73	=	7.49	+	3.44	+	3.8
(8)	19.59	=	18.05	+	0.71	+	0.83
(9)	9.85	(see Table III.)					

All the above atomic volumes and part-volumes are confirmed by experimental data in Table II.

TABLE II.

	Relative Volume.	Theor S.G.	Obs. S.G.	
(10)	Ca = KH 13.25 = 7.49 +5.76			
(11)	CaH_2 13.25 + 2(5.76)	1.7	1.7	Kaye
(12)	Rb = Na_2K 26.57 = 2(9.54) + 7.49			
(13)	RbI 26.57 + 32.77	3.57	3.567	Setterberg
(14)	Ca = SiC 12.24 = 11.53 + 0.71			
(15)	CaS 12.24 + 15.53	2.59	2.58	Maskelyne
(16)	Si 11.53	2.43	2.34	Miller
			2.48	Playfair
(17)	Ca = SiC 14.54 = 13.83 + 0.71			
(18)	$CaCl_2$ 14.54 + 2(15.085)	2.48	2.48	Playfair
(19)	Si 13.83	2.025	2.004 - 2.194	Winkler
(20)	As = CuC 12.98 = 9.54 + 3.44			
(21)	As 12.98	5.778	5.766	Mohs
			5.884	Turner
(22)	CuS 9.54 +15.53	3.8	3.8	Nostrand
(23)	Zn 9.03	7.2	7.2	Roberts
(24)	Cu_7Zn 4(7.13) + 9.03	8.585	8.587	Mallet
(25)	Cu_1Zn (4(7.13) + 9.03	· 8.442	8.448	Mallet
(26)	Cu_8Zn_{20} 8(7.13) + 20(9.03)	7.6	7.603	Mallet
(27)	$CuZn_5$ 7.13 + 5(9.03)	7.43	7.442	Calvert
(28)	$ZnCl_2$ 9.03 + 23.01 + 15.085	2.9	2.91	25°/4 Nostrand
(29)	$CoZn_4$ 6.78 + 4(9.03)	7.436	7.43	0°/4 Dugelliez
(30)	Co 6.78	8,702	8.71	Lampadius
			8.558	Henry
(31)	BiZn 21.29 + 9.03	9.04	9.046	Calvert
(32)	Bi 21.29	9.82	9.82	Roberts
(33)	ZnS 9.03 + 15.53	3.95	3.98	Nostrand
			3.9235	Karsten
(34)	S 15.53	2.0605	2.063	Deville
			2.05	Karsten
(35)	ZnSe 9.03 + 17.43	5.40	5.40	15° Margottet
(36)	Se 17.43	4.475	4.47	25° Nostrand
(37)	$Zn(NO_3)_2.6H_2O$ 9.03 + 2(3.8) + 6(7.53) + 6(14.03)	2.034	2.063	18° Laws
(38)	ZnO 11.76 + 2.51	5.68	5.684	Riche
(39)	ZnO_2H_2 11.76 + 7.53 + 2.51 + 2(5.76)	2.97	3.06	Filhol
			2.68	Nickles
(40)	ZnF_2 11.76 + 2(5.42)	4.557	4.556	17° Clarke
(41)	ZnO. Al_2O_3 11.76 + 2.61 + 2(9.05) + 3(2.51)		4.589	Rose
		4.586	4.580	Ebelmen

(42)	Al_2O_3 2(9.05) + 3(2.51)	3.98	3.98	14° Grandeau
(43)	2ZnS. FeS 2(11.76) + 2(15.58) + 7.05 + 10.51	3.91	3.911	Breithaupt
(44)	FeS 7.05 + 10.51	5.01	5.085 4.75	Playfair and J. Smith
(45)	4ZnS. ZnO 4(11.76 + 15.58) + 11.76 + 2.51	3.80	3.8	Vogl
(46)	$ZnSO_4.2NH_3$ 11.76 + 30.59 + 2(0.88) + 6(5.76)	2.48	2.479	Playfair and J.
(47)	$ZnSO_4$. 14.73 + 30.59	3.552	3.552	Schroder
(48)	$ZnSO_4.6H_2O$ 14.73 + 30.59 + 6(14.03)	2.077	2.072	15° Thorpe
(49)	$Am_2Zn(SO_4)_2.6H_2O$ 2(23.87) + 14.73 + 2(30.59) + 6(14.03)	1.93	1.932 1.925	20°/4 Internl Schroder
	(where 23.87 = 0.88 + 4(5.76))			
(50)	$ZnSO_4$ 14.73 + 29.45	3.644	3.6235 3.681	15° Thorpe Playfair and J.
(51)	$ZnSO_4.5H_2O$ 14.73 + 29.45 + (5(14.03)	2.2	2.206	15° Thorpe
(52)	$ZnSO_4.7H_2O$ 14.73 + 29.45 + 7(14.03)	2.015	2.015	Schroder
(53)	$ZnCl_2.2NH_3$ 14.73 + 2(15.085) + 2(0.88) + 6(5.76)	2.09	2.09	Johnsen
(54)	$Rb_2Zn(SeO_4)_2.6H_2O$ 2(22.29) + 19.59 + 2(35.21) + 6(14.03)	2.867	2.868	20°/4 Tutton
(55)	Rb_2SeO_4 2(22.29) + 35.21	3.91	3.896 - 3.923	Pettersson
(56)	$K_2Zn(SeO_4)_2.6H_2O$ 2(18.05) + 19.59 + 2(35.21) + 6(14.03)	2.544	2.558	20°/4 Tutton
(57)	K_2SeO_4 2(18.05) + 35.21	3.08	3.077	20° Pettersson
(58)	$ZnCl_2$ 19.59 + 2(15.085)	2.733	2.753	18° Bodeker
(59)	$ZnSO_4.7H_2O$ 19.59 + 30.59 + 7(14.03)	1.984	1.981	Playfair and J.
(60)	$ZnSO_4.7H_2O$ 19.59 + 29.45 + 7(14.03)	1.95	1.953	Schiff
(61)	Zn 9.85	6.60	6.55 6.861	Roberts and W. Brisson
(62)	ZnTe 9.85 + 20.55	6.348	6.34	15° Margottet
(63)	Te 20.55	6.229	6.229 6.015	40° Spring 20° Nostrand

TABLE III.

	Heat of Formation	Original Volume		Rel Vol in combination	Change of Volume
(64)	- 14900 = 120 × (-1.91) × 65	9.85	=	11.76	- 1.91
(65)	6896 = 120 × 0.82 × 65	9.85	=	9.03	+ 0.82

TABLE IV

	Heat of Formation.		Theor.	Obs.	
(66)	Zn. O. H_2O - 14900 + 96155 + 0	=	81255	82680	
	(corresponds with No. 38)				
(67)	Zn.F_2 - 14900 + 2(76820)	=	138740	138220	
	(corresponds with No. 40)				
(68)	aq. Zn.F_2 - 14900 + 2(77500)	=	140100	140000	
(69)	Zn.Br_2 - 14900 + 2(45244)	=	75588	75930	76000
(70)	aq. Zn. Br_2 - 14900 + 2(52930)	=	90960	90960	T
(71)	Zn. I_2 6896 + 7010 + 36226	=	49682	49230	

(72)	aq : Zn. I_2 14900 + 2(37720)	=	60510	60540	T
(73)	Zn. $O_2.H_2$ −14900 + 32341 + 96155 − 2(15300)	=	82996	82680	T 83500
	(corresponds with No. 39)				
(74)	Zn. Cl_2 − 14900 + 2(56786)	=	98672	97400	
(75)	aq. Zn. Cl_2 14900 + 2(63870)	=	112840	112840	
(76)	aq. Zn. O_2. N_2O_4 − 14900 + 2(32341) + 85332	=	135114	134980	
(77)	aq. Zn. O. N_2O_5 14900 + 32341 + 85332	=	102773	102510	
(78)	aq. $Ag_2.O_2.N_2O_4$ − 2(50300) + 2(32341) + 85332	=	49414	49250	
(79)	aq. Ag_2.O. N_2O_5 − 2(50300) + 32341 + 85332	=	17073	16780	
(80)	aq. Ca.Cl_2 73583 + 2(63870)	=	201273	201300	T
(81)	aq.Ca.Br_2 73583 + 2(52930)	=	179893	179430	T
(82)	Ca. O 64420 + 96155	=	160575	160000	(*Chem. News*, 1920 CXXI., 250.)
(83)	Ca. F_2 64420 + 2(76820)	=	218060	218400	216450
(84)	aq. Co.F_2 − 32920 + 2(77500)	=	122080	122200	
(85)	aq. Co.I_2 − 32920 + 2(37720)	=	42520	42520	T
(86)	Zn.$O_2.N_2O_4.6H_2O$ 6396 + 2(32341) + 85332 − 6(8205)	=	137180	140820	
	(corresponds with No. 37)				
(87)	aq. Zn. S.O_4 − 14900 + 6217 + 2(32341 + 96155)	=	248309	248030	
(88)	liq. H_2.O − 2(24350) + 117460	=	68760	68360	Thomsen
				69000	Berthelot
(89)	aq. H. Cl. − 24350 − 63870	=	39520	39315	T
(90)	aq. H.N.O_3 − 24350 − 23300 + 3(32341)	=	49373	49090	T
(91)	aq. K.O.H. 37274 + 96155 − 15300	=	118129	117890	
(92)	aq. K.O.H. 36100 + 96155 − 15300	=	116955	116460	T
(93)	aq. K_2.S.O_4 2(37274) + 6217 + 2(32341) + 2(96155)	=	337757	338000	
(94)	aq. Ba.Cl_2 72184 + 2(63870)	=	199874	199210	
(95)	Ba.S.O_4 81926 + O + 2(32341 + 96155)	=	338918	339400	
(96)	aq. H_2.S.O_4.H'_2O − 2(24350) + 6217 + 2(32341 + 96155) − 8205	=	211304	210770	T

HEAT OF NEUTRALISATION.

When (66) and (96) produce (87) and three times (88), the only changes that occur are:—

96155 becomes 117460
− 8205 becomes 0

(97) 117460 − 96155 + 8205 = 24510 23410 T

HEAT OF SOLUTION OF METAL.

When Zn and twice (89) produce (75) and H_2,

O becomes − 14900
− 2(24350) becomes 0

(98) − 14900 + 2(24350) = 33800 34210 T

HEAT OF SOLUTION.

When (69) produces (70),

2(45244 becomes 2(52930)

(99) 2(52930) − 2(45244) = 15372 15030 T

HEAT OF DECOMPOSITION.

When (87) and (94) produce (75) and (95),

72184 becomes 81926
6217 becomes O

(100) 81926 − 72184 − 6217 = 3575 5504 T

HEAT OF SOLUTION.

When (71) produces (72,

6396 becomes - 14900

7010 becomes 87720

36226 becomes 87720

(101) - 14900 - 6396 + 2(87720) 7010

- 36226 = 10908 11310 T

HEAT OF NEUTRALISATION.

When (66) and twice (89) produce (75) and twice (88), the only change is :—

96155 becomes 117460

(102) 117460 - 96155 = 21305 19880 T

HEAT OF SOLUTION.

When (74) produces (75),

2(56786) becomes 2(63870)

(103) 2(63870) - 2(56786) = 14168 15630 T

The volume 11.76 is exact for ten independent reasons :—

(A1-A7) Because there are 7 independent S.G.'s which give this number;

(A8) Because it can be split up in accordance with the law of relative volume (No. 6);

(A9) Because it forms a constituent part of Cd, as will be shown later;

(A10) Because it falls in with the law of heat of formation.

Similarly, 9.08 is exactly correct for 14 reasons.

An important confirmation of the correctness of the above proof as a whole is that similar proofs have been or are being produced of the constitution of each element.

SUMMARY.

108 facts have been arranged here in such a manner as to demonstrate the truths which underlie them; and the most important fact of all is that the atomic weight of Zn is 65. If it had been supposed to be any other number, the above intricate interdependence of facts could not have been discovered. The recently recorded isotopes 64, 66, etc., were obtained by exceedingly violent electrical operations upon electrical matter.

In addition to proving that Zn = KCN, this paper accomplishes the following objects :—

(B1) It continues the reduction of the data of S.G. to exact instruments of research;

(B2) It strengthens the law of relative volume;

(B3) It strengthens the law of heat of formation ;

(B4) It continues the demonstration that water of crystallisation is not equivalent to ice by 8 molecules in Table II, and also by No. 97;

(B5) It continues the demonstration that the H.F. of a substance cannot be obtained with any certainty *by calculation* without the previous knowledge of the relative volume of each atom in the molecule.

Zinc is an exception to the Odd and Even Rule, because it contains N. which is the only exception amongst the elements of at. wt. less than 60.

The theoretical H.F. of each molecule containing Zn in Table IV. is doubly confirmed (i) by the law of H.F., and (ii) by comparison with similar compounds of other metals.

The theoretical H.F. of any particular molecule is considered to correspond with the experimental value, if the two results differ by less than 2000, because experimental results by different experimentalists frequently differ by more than 2000.

BRASS STAMPINGS.

FROM A CORRESPONDENT.

The specialised engineering operation of brass stamping is of great importance in many different industries because it enables brass fittings and parts of every description to be supplied at a remarably cheap rate. This is particular value, for example, in the manufacture of scientific instruments of all kinds, as well as in the electrical and the motor vehicle industries, locomotive and marine engineering, and gas, water, and steam fittings, to mention a few cases only.

The principle consists essentially in the manufacture of every description of brass fitting, often of the most intricate character,

to very fine dimensions, by stamping them out bodily with the aid of steel dies in one operation from the highly heated brass, supplied to the machine in the form of sections of rod or other convenient shape. Two operators work one machine, which has, fixed adjacent, a very slowly revolving gas-fired furnace, the heated section of rod (after having completed the journey round and reached the right temperature), being lifted out with a pair of tongs and placed in the die under the stamp; the finished part being then lifted out, the whole operation only taking a few seconds. The number of different articles made in this way runs into hundreds, but to give merely one or two examples only, we have camera focussing screws, telephone levers, bases, and brackets, small rollers and links for all kinds of recording apparatus, such as pyrometers, for example, and discs and many other parts for calculating machines.

The advantage of stamping as compared with the older method of casting the brass and then machining it includes in the first place a high-grade and uniform product, since the great pressure exerted momentarily during the process improved the texture of the metal, and the fact that the percentage of "wasters" due to blow holes, flaws, dirt, and impurities is almost entirely eliminated. The chief point, however, is the obviously enormous increase in output rendered possible and the great saving in labour, constituting a revolution in the production of small brass articles.

One of the most prominent British firms for brass stamping is Sutcliffe Speakman & Co., Ltd., of Leigh, who turned out during the war period approximately 40,000,000 brass fuse bodies, adaptors, timing rings, and similar fittings, manufacturing during the worst emergency period no less than 800,000 stampings weekly, representing the consumption of 350 tons of brass and the work of 1,200 employees.

Production on such a gigantic scale necessitated the employment of the most modern plant and machinery, combined with the highest scientific supervision, especially to fulfil the severe Admiralty specifications, and as showing the extreme accuracy obtained by modern methods of stamping, the firm turned out a number of million timing rings for shells, accurate at one operation to one four-thousandth part of an inch, a feat that had hitherto not been possible.

Finally, it may be stated that brass stamping is only another example along with optical glass, fine chemicals, ether, scientific instruments, magnetos, ashless filter papers, and laboratory apparatus, of an industry in which before the war, Germany held a commanding position which no longer exists as far as Great Britain is concerned.

THE GRAPHITE INDUSTRY.

A recent statement by Professor Benjamin Le Roy Miller, of the department of geology, Lehigh University, U.S.A., is a good resume of the graphite situation.

In the discussion of the present situation with reference to almost any of our economic mineral products it is necessary to review the records of the past ten years or more for a proper appreciation of present conditions. The pre-war, war, and post-war periods afford striking contrasts in practically every industry based on our raw materials, and so rapidly did we pass from one period to another that it is not surprising to find a great unsettling of conditions and consequent hardships resulting. Graphite was one of the important war minerals, although a minor one from the standpoint of quantity consumed, and the graphite industry accordingly responded quickly to the enormously increased demand occasioned by the war and slumped with equal rapidity at its sudden termination. The pre-war situation was simple, the war problems complex and confused, and the post-war conditions demoralising.

Graphite is distinctly an international mineral product. It is found in almost every country in the world, but is not mined for export in most of them and is utilised in any considerable quantities only in the manufacturing countries of Western Europe and the United States. Indeed, two of the countries where there are extensive graphite-manufacturing interests, France and England, have been entirely dependent upon foreign supplies of graphite, and every manufacturing country in pre-war times looked to one or more foreign countries for the supply of certain kinds of graphite.

During the war, several of the countries attempted to make themselves independent through the development of domestic mines. Germany, because of necessity, succeeded in doing so, and the United States made strong strides in that direction, while France was able to dispense with

practically all foreign supplies other than that obtained from its colony, Madagascar. In the period following the armistice, there has been a tendency to return to pre-war usages, yet not entirely, as the stream of trade, once diverted, seldom returns to its old channel.

The crystalline graphite of international importance is produced in Ceylon ,Madagascar, the United States, and Canada, and is mainly used in the manufacture of crucibles for the steel and brass industries, with the poorer grades used for lubricants, paint, stove polish, and foundry facings. Amorphous graphite comes mainly from Czechoslovakia (Bohemia principally, but some from Moravia), Austria, Chosen (Korea), Italy, the United States, and Mexico, and is used for foundry facings, lubricants, stove polish, pencils, and paint. Artificial (or manufactured) graphite is made only in the United States and is principally used in the production of electrodes.

In addition to this classification, we must recognise different varieties. Of crystalline graphite there are two distinct kinds, each adapted for a particular use. Ceylon produces vein graphite that has long been considered so superior to any other form of graphite for crucible manufacture that it has dominated in that field. In Montana there is a deposit of similar material, but up to the present time, of little importance. Madagascar, the United States, and Canada produce mainly a variety of crystalline graphite that occurs as disseminated thin flakes in highly metamorphosed rocks.

Before the war, flake graphite was used sparingly for crucibles, but, due to the difficulty of getting the Ceylon variety during the war, French, German, and Austrian graphite-crucible manufacturers substituted flake graphite almost entirely, and in England and the United States, the manufactures used the flake material in larger proportions than before. Certainly there has been a change of sentiment in regard to the necessity of Ceylon graphite for crucibles, although in the United States the crucible manufacturers seem to still favour it rather than the domestic or Madagascar flake that is more easily obtainable. This is true in spite of the fact that experiments conducted by the United States Bureau of Mines have seemed to indicate that domestic flake graphite from Alamaba was equal if not superior to the Ceylon variety. If this is true, the situation of the manufacturers clinging to the continued use of a higher-priced and perhaps inferior product is an anomalous one and may be due to their conservatism or to their lack of knowledge as to how to get the best results from flake graphite. Whatever the explanation, it is certain that they are still unconvinced that they can entirely substitute the flake variety for the Ceylon without injuring the quality of their crucibles, and at the present time there is not sufficient evidence to say whether they are right or wrong.

The U.S.A. Geological Survey reports the sales of domestic graphite in the United States rose from 3,125 short tons in 1922 to 6,038 tons in 1923, an increase of 93 per cent. Of this increase the amorphous variety contributed 1,856 tons, which was a gain of 84 per cent., and the crystalline variety contributed 1.057 tons, a gain of 114 per cent. By considering the sales of graphite in five-year periods, the effect of the war is clearly discernible. The average total production for the five-year period from 1909 to 1913 (exclusive of graphitic slate from Georgia) was 3,999 short tons; during the war period, from 1914 to 1918, it was 8,745 tons; and from 1919 to 1923 it was 5,706 tons. It will thus be seen that the average of sales durin gthe war period was more than twice as great as that of the preceding five-year period, and more than 50 per cent. greater than that of the following five-year period. Imports of graphite during the same periods increased from a five-year average of 24,345 short tons for 1909-1913 to 30, 014 tons for 1914-1918, and declined to 17,565 tons for 1919-1923.

TECHNOLOGY OF COTTON MACHINERY.

Part I.—Calculations on Pickers.

By A. A. Mercier (Bureau of Standards, U.S.A)

A study was made of the calculations on cotton pickers which may be applied to similar machines in the industry or to like machines used in experimental or research work. Methods are given for finding (a) the revolutions per minute of pulleys, rolls, and various moving parts; (b) the ratio between surface speeds of rolls; (c) the production resulting from the revolutions of the calender or delivery rolls and weight of lap; and (d) the amount of beating given the cotton. The speed of the beater is used as a basis or starting point when calculating the speed of rolls and fans.

The machines from which the diagrams were taken are of the ordinary commercial type and represent machines put out by two manufacturers of well-known cotton mill machinery. The calculations are put into the form of tables and charts, permitting the formation of "organisations" with ease and rapidity. The speeds are used in connection with production, the draft with regard to the weight of the lap, and the blows per inch are determined with regard to the amount of cleaning the cotton will receive. The settings of feed rolls and grids to the beater have not been considered in these calculations. The production of the pickers is tabulated for beater speeds from 500 to 1,500 revolutions per minute, when using feed pulleys from 5 to 15 inches in diameter, and for laps weighin gfrom 5 to 20 ounces per yard. Various drafts, draft constants, and blows per inch are also included in the calculations.

The contents of this paper may be summarised as giving the methods and formulas for determining :

(a) Sizes and revolutions per minute of pulleys.
(b) Revolutions of calender rolls.
(c) Draft, draft gears.
(e) Productions in yards delivered by the calender rolls for laps of different weight per yard.
(f) Amount of beating given cotton.
(g) Assembling of data into organisations.

The charts and tables set forth the data in detail and give a wide range of speeds, diameters of pulleys, teeth in gears, and weight of product.

General Notes.

CANADIAN MINING NEWS.

Minerals in the Arctic Circle.

The extent and value of the mineral deposits in the Arctic regions are to form part of the subjects of investigation by the expedition now *en route* there. Professor Weeks, a graduate of Arcadia and Yale Universities, is in the party representing the Geological Survey of Canada, and his examination will cover territory that hitherto has not been investigated. He has full geological equipment and outfit. The presence of minerals is well established, the only question being whether they are available to such an extent as would make operations economically feasible.

Mica Discovery Looks Big.

What is claimed to be the largest show of mica unearthed in Ontario has been discovered at North Hastings, a short distance from Bancroft, by Sorser and Company, who shipped three cars, 120 tons, to the United States market. Crystals weighing as much as two tons have been taken from the show. The company proposes starting a cutting factory here in the near future for the purpose of cutting mica to size. Experts who have visited the property, claim it to be the largest yet found in Ontario.

CHEMICAL, METALLURGICAL AND MINING SURVEY OF SOUTH AFRICA.

The following constitute the new Council of the above Society, as announced at the annual meeting which was held at Johannesburg on June 27, 1925 :—

President—Mr. H. A. White (unopposed).

Vice-Presidents—Messrs. H. R. Adam, A. King, and J. A. Woodburn (unopposed).

Honorary Treasurer—Mr. J. R. Thurlow (unopposed).

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CANADIAN DAIRY FACTORIES.

Although there were fewer dairy factories in operation in Canada last year, their produce showed on increase in value of over 4,023,080 dollars. In 1924 the factories totalled 2,998 (a reduction of 9 on the previous year) and the produce was valued at 124,143,470 dollars.

UNITED STATES TRADE AND INDUSTRY.

Moderate fall buying is stimulating wholesale trade in the United States, and several important industries show an increase in activity, states a cable received by the London Office of the Guaranty Trust Company of New York. Favourable weather has improved the agricultural outlook. Crop deterioration for July is reduced and the indicated yields of maize and wheat, oats, barley and potatoes have im-

proved. The cotton forecast of August 1 was 13,566,000 bales, against 13,588,000 bales, the previous estimate.

Pig iron production in July averaged 85,936 tons daily against 89,115 for June and 57,577 for July a year ago. Average steel ingot output for July was 118,753 tones daily against 123,348 for June and 72,223 for July last year. Unfilled orders of the United States Steel Corporation on July 31 were 3,539,467 tons against 3,710,168 tons in June and 3,187,072 tons a year earlier, and there is increased activity and larger buying this month. The net operating income of Class 1 railroads for the first half-year represents an annual return or 4.46 per cent. on property investment against 4.12 per cent. a year earlier.

Employment in the manufacturing industries in July was 1.1 per cent. below June; employees' earnings decreased 2.4 per cent. and the *per capita* earnings decreased 1.3 per cent. The decreases are largely seasonal and much smaller than a year ago. The consumption of line cotton for the year ended 31st July was 6,191,349 bales against 5,680,554 bales in the preceding year. Building contracts for July were a seasonal record, being 53 per cent. above a year ago, but exceeding only April and June this year.

NEW IRISH FREE STATE PATENT LAWS.

Important Provisions.

Valuable interests will be involved in the changes arising from the new Patent Laws which will shortly come into force in the Irish Free State. Mr. Geo. H. Rayner, the well-known Chancery Lane Patent Agent, makes clear several of the points needing careful consideration by those concerned.

British patents granted before December 6, 1921, will be continued upon the Irish register if a copy of the patent is lodged in Ireland and renewal fees are paid as in England.

British patents applied for after December 6, 1921, and before the passing of the Act, will be granted subject to a search in the Irish register. These privileges in regard to patents will also extend to registered trade marks and designs.

Should an application for a patent be made without reference to any earlier British patents, then it must be accompanied by the report of a registered patent agent based upon a search for novelty in the British Records.

Should any of our readers desire fuller information on this subject, Messrs. Rayner and Co., Patent Agents, of 5, Chancery Lane, London, W.C.2., will be glad to supply it free of charge.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Southampton, 1925.

The annual meeting was held from August 26 to September 2.

THE PRESIDENTIAL ADDRESS.

By Professor Horace Lamb, Sc.C., LL.D., F.R.S., (President of the Association).

" When one is confronted as on this occasion with the British Association in plenary session, it is permissible, I hope, to indulge in a few reflections on the nature and purpose of science in general. The theme is no new one and has never been discussed so frequently as in our time, but the very range of our activities entitles us to consider it from our own point of view. The subjects treated at these meetings range, according to the titles of our sections, from the most abstract points of mathematical philosophy to the processes of agriculture. Between these limits we have the newest speculations of Astronomy and Physics, the whole field of the biological sciences, the problems of engineering, not to speak of other matters equally diverse. These subjects, again, have become so subdivided and specialised that workers in adjacent fields have often a difficulty in appreciating each other's ideas, or even understanding each other's language. What then is the real purpose of science in the comprehensive sense, what is the common inspiration, the common ambition behind such enthusiastic and sustained effort in so many directions? The question may seem idle, for a sort of official answer has often been given. It was deemed sufficient to point to the material gains, the enlarged powers which have come to us through science, and have so transformed the external part of our lives. The general aim was summed up in an almost consecrated formula, " To subdue the forces of nature to the service of man.' And since it was impossible to foresee what abstract research might or might not provide a clue to something useful, the more speculative branches

of science were not only to be tolerated, but to be encouraged within limits, as ancillary to the supreme end. And, it must be said, the cultivators of these more abstruse sciences have themselves been willing to accept this position. The apologists of Pure Mathematics, for instance, have been wont to appeal to the case of the conic sections, which from the time of Apollonius onwards had been an entirely detached study, but was destined after some 2,000 years to guide Kepler and Newton in formulating the laws of the planetary motions, and so ultimately its justification in the Nautical Almanack. I will not stop to examine this illustration, which I personally think rather strained. We may recognise that practical utility has been a conscious thought though not the sole aim in much scientific work, and sometimes perhaps its main justification; but we can hardly admit that any such formula as I have quoted worthily conveys what has been the real inspiration of discovery through the ages. If we may go back to Apollonius and the conic sections, we cannot suppose that he was thinking of posterity at all; he was engaged in a study which he no doubt held to be legitimate and respectable in itself. Or, to take a very recent instance, when Faraday and Maxwell were feeling their way towards an electric theory of light, they could hardly have dreamed of wireless telegraphy, though as we now know, this was no remote development. The primary aim of science as we understand it is to explore the facts of Nature, to ascertain their mutual relations, and to arrange them as far as possible into a consistent and intelligible scheme. It is this endeavour which is the true inspiration of scientific work, as success in it is the appropriate reward. The material effects come later if at all, and often by a very indirect path. We may, I think, claim for this constructive task something of an æsthetic character. The provinces of art and science are often held to be alien and even antagonistic, but in the higher processes of scientific thought it is often possible to trace an affinity. The mathematician at all events is at no loss for illustrations of this artistic faculty. A well-ordered piece of algebraical analysis has sometimes been compared to a musical composition. This may seem fantastic to those whose only impression is that of a mass of curious symbols, but these bear no more resemblance to the ideas which lie behind them than the equally weird notation of a symphony bears to the sounds which it connotes or the emotions which these evoke. And it is no misplaced analogy which has led enthusiasts to speak of the poetical charm of Lagrange's work, of the massive architecture of Gauss's memoirs, of the classic perfection of Maxwell's expositions. The devotees of other sciences will be at no loss for similar illustrations. Is it not the case, for instance, that the widespread interest excited by the latest achievements of physical science is due not to the hope of future profit, though this will doubtless come, but to the intrinsic beauty as well as the novelty of the visions which they unfold?

It is possible, I trust, to insist on these aspects of the scientific temperament without wishing to draw a sharp and even mischievous antithesis between pure and applied science. No to speak of the enormous importance in our present civilisation of the material advantages which have come in the train of discovery, it would be disloyal to science itself to affect to depreciate them. For the most severely utilitarian result comes often as the result of a long and patient process of study and experiment, conducted on strictly scientific methods. We must recognise also the debts which pure science in its turn owes to industry, the impulse derived from the suggestion of new problems, and not least the extended scale on which experiment becomes possible. And a reference may appropriately be made here to the National Physical Laboratory(initiated mainly in the higher interests of industry, which by the mere pressure of the matters submitted to it is becoming a great institute of theoretical as well as applied science, informed throughout by the true spirit of research.

But perhaps the most momentous consequences of the increased scientific activities of our time have been on the intellectual side. How profound these have been in one direction we have recently been reminded by the centenary of Huxley. Authority and science were at one time in conflict over matters entirely within the province of the latter. The weapons were keen, and the strife bitter. We may rejoice that these antagonisms are now almost obsolete; one side has become more tolerant, the other less aggressive, and there is a disposition on both sides to respect each other's territories. The change is even reflected

in the sermons delivered before the Association. The quarters where we may look for suspicion and dislike are now different; they are political rather than ecclesiastical. The habit of sober and accurate analysis which scientific pursuits tend to promote is not always favourable to social and economic theories which rest mainly on an emotional if very natural basis. Some of us ,for instance, may remember Huxley's merciless dissection of the theory of the social contract. There is hence to be traced, I think, a certain dumb hostility which, without venturing on open attack, looks coldly on scientific work except so far as it is directed to purposes of obvious and immediate practical utility.

There is a more open kind of criticism to which we are exposed, which we cannot altogether ignore, though it again rests on a misconception of the true function of science. It is to be met with in quarters where we might fairly look for countenance and sympathy, and is expressed sometimes with great force, and even eloquence. The burden is one of disappointment and disillusion; we even hear of the 'bankruptcy of science.' It seems to be suggested that science has at one time or other held out promises which it has been impotent to fulfil, that vague but alluring hopes which it has inspired have proved delusive. It may be admitted that extravagant and impossible claims have sometimes been made on behalf of science, but never, I think, by the real leaders, who have always been most modest in their claims and guarded in their forecasts. It is true again that in the enthusiasm which attended the first sensational developments of modern industry hopes were conceived of a new era, where prosperity would ever increase, poverty would be at least mitigated and refined, national antipathies would be reconciled. When these dreams did not swiftly come true there was the inevitable reaction, the idols were cast down, and science in general has rather unreasonably come in for its share of depreciation. The attitude which I have been trying to describe is put very forcibly in a quotation from President Wilson which I saw not long ago, though its date is not very recent:

'Science has bred in us a spirit of experiment and a contempt for the past. It has made us credulous of quick movement, hopeful of discovering panaceas, confident of success in every new thing. . . I should fear nothing better than utter destruction from a revolution conceived and led in the scientific spirit. Science has not changed the laws of social growth or betterment. Science has not changed the nature of society, has not made history a whit easier to understand, human nature a whit easier to reform. It has won for us a great liberty in the physical world, a liberty from superstitious fear and from disease, a freedom to use nature as a familiar servant, but it has not freed us from ourselves.'

The tone is one of bitter disillusion, but we may ask why should science, as we understand it, be held responsible for the failure of hopes which it can never have authorised? Its province as I have tried to define it is vast, but has its limits. It can have no pretensions to improve human nature; it may alter the environment, multiply the resources, widen the intellectual prospect, but it canot fairly be asked to bear the responsibility for the use which is made of these gifts. That must be determined by other and, let us admit it, higher considerations. Medical science, for instance, has given us longer and healthier lives; it is not responsible for the use which we make of those lives. It may give increased vitality to the wicked as well as to the just, but we would not, on that account, close our hospitals or condemn our doctors.

In spite of the criticisms I have referred to we may still hold up our heads, let us hope without arrogance, but with the confidence that our efforts have their place, not a mean one, in human activities, and that they tend, if often in unimagined ways, to increase the intellectual and the material and even the æsthetic possessions of the world. And in that assurance, we may rejoince that science has never been so widely and so enthusiastically cultivated as at the present time, with so complete sincerity, or (we may claim) with more brilliant success, or even with less of international jealousy.

Passing from these reflections which are, I hope, not altogether inopportune, it is expected that the President for the time being should deal with some subject in which he has himself been interested. For a mathematician this obligation is a specially difficult one, if he is not to overstrain the patience of his audience. I propose to speak briefly, and mainly from the mathematical and physical standpoint, about some branches of Geophysics, and in particular those relating to the constitution of the earth. It is a subject which in the past has often enaged the attention

of the Association; I need only recall the names of Kelvin and George Darwin, and the controversies with which they were associated. Historically, it is of special interest to the mathematician and the physicist, for it was in his researches on the figure of the earth that Laplace initiated the theory of its potential, with its characteristic equation, and so prepared the way for Poisson ,Green, Cauchy, and a host of followers, who developed the theory of electricity and ultimately that of light. To go further back, it was in this connection that Newton found an important verification of his law of gravity. Quite recently, the whole subject has been reviewed in a valuable treatise by Dr. Jeffreys, who arrives at conclusions which are at all events definite, and maintained with great ability.

I do not propose to deal with the fascinating speculations as to the past history of the earth and its reputed child, the moon, which will be more or less familiar. I must confine myself to a rapid survey of the information as to its present constitution which can be gathered from observations made in our own time, and capable of repetition at will. This, though less exciting, is at all events a region in which imagination is more subject to control.

The accurate investigation of the figure of the earth is intimately connected with the variation of gravity over its surface. In view of the local irregularities, some convention was necessary as to what is meant by the shape of the earth as a whole. The usual definition is that it is a level surface as regards the resultant of true gravity and centrifugal force; often that particular level surface of which the sea forms a part. I need not dwell on the immense amount of theoretical and practical labour which has been devoted in various countries to the determination of the geometrical peculiarities which are at all events of considerable interest. I may add that it is contemplated that the Cambridge apparatus should also be designed to eliminate the disturbing element I have mentioned, and that it should be available for determinations at sea. It is perhaps not too much to hope that with the co-operation of the Navy, the gravity chart of the world, which is so far almost a blank as regards the ocean, may in this way be gradually filled in.

The distribution of the intensity of gravity over the surface of the earth gives by itself no positive information as to the distribution of density throughout the interior, though the contrary view has sometimes been held. For example, a spherical globe with a uniform intensity of gravitation over its surface would not necessarily be homogeneous, or even composed of spherical strata each of uniform density, however plausible this might be on other grounds. Consequently, there is room for hypothesis. There are certain tests which any hypothesis has to satisfy. It must account for the observed distribution of gravity, and having regard to the phenomena of precession, it must give the proper relation between the earth's moments of inertia about a polar and an equatorial axis. It may be added that it should be fairly consistent with the ascertained velocities of seismic waves at different depths, and the degree of elasticity which it is allowable to assign to the material. The somewhat artificial laws of density adopted by Laplace and Roche, respectively, mainly on grounds of mathematical convenience, have lost much of their credit. A more natural law, suggested indeed by Thomson and Tait in 1867 in their book on Natural Philosophy, has since been proposed in a more definite form by Wiechert. On this view the earth is made up of a central core of about four-fifths the external radius, of high density, about that of iron, surrounder by an envelope of about the density of the surface rocks. This is, of course, only to be taken as a rough picture, but it satisfies the requirements I have mentioned, and is apparently not incompatible with the seismic data.

In all speculations on the present subject, considerations as to the thermal history of the earth and the present distribution of temperature in the interior play an essential part. The apparent inconsistency between the requirements of physics and geology was long a matter of controversy, and has given rise to keen debate at these meetings. Lord Kelvin's historic attempts to limit the age of the earth by consideration of the observed temperature gradient as we go downward from the surface lost their basis when it was discovered that the rate of generation of heat in the processes of radioactive change was amply sufficient to account for the present gradient, and would even be far more than sufficient unless the amount of radioactive material concerned were strictly limited. Assuming an average distribution of such material similar to what is found near the surface, a stratum of some 16 kilometres in thick-

ness would provide all that is wanted. Radioactive speculation has gone further. A comparison of the amounts of uranium, and of the end-products associated with it, has led to estimates of the time that has elapsed since the final consolidation of the earth's crust. The conclusion is, that it must lie definitely between 10^9 and 10^{10} years. The figure is necessarily vague owing to the rough value of some of the data, but even the lower of these limits is one which geologists and biologists are, I believe, willing to accept, as giving ample scope for the drama of evolution. We may say that physics has at length amply atoned for the grudging allowance of time which it was once disposed to accord for the processes of geological and biological change. The radioactive arguments on which these estimates are based are apparently irrefutable; but from the physical point of view there are reasons why one would welcome an extension even of the upper limit of 10^{10} years, if this could possibly be stretched. For if this barrier be immovable, we are led to conclusions as to the present internal temperature of the earth which are not quite easy to reconcile with the evidence as to rigidity to be referred to in a moment. In the space of time I have mentioned, enormous as it is, the great mass of the earth could hardly have cooled very much from the temperature when it was in a state of fusion. The central portion, whatever its nature, and however high its thermal conductivity, is enclosed by a thick envelope of feebly conducting material, just as a stea mboiler, for instance, may be jacketed with a layer of asbestos. To take a calculable hypothesis, we may assume with Wiechert that we have a central core of three-fourths the earth's radius, with an outer shell of rock. We may give the core any degree of conductivity we like, for mathematical simplicity we may even regard it as infinite. Then, if the outer layer consists of material having some such conductivity as the surface rocks, the internal temperature would take to fall to one half its original value a period of at least ten times the limit I have named. It is obvious that the details of the assumption may be greatly varied without affecting the general conclusion of a very high internal temperature.

The question as to the degree of rigidity of the earth has so often been dealt with, that a brief recapitulation will suffice. It was about the year 1862 that Kelvin first pointed out that if the earth as a whole were only as rigid as a globe of glass or even steel, it would yield so much to the deforming action of the solar and lunar tidal forces as seriously to affect the amplitudes of the oceanic tides, which are a differential effect. Unfortunately, the tides are so much complicated by the irregular distribution of land and sea that a comparison of the theoretical amounts which they would have on the hypothesis of absolute rigidity with the actual values is hopeless. The fortnightly tidal component, due to the changing declination of the moon ,is probably an exception, but the difficulty here is to extract this relatively minute component from the observations, and the material is consequently imperfect. The problem was attacked in a different way by G. and H. Darwin in 1881. The horizontal component of the lunar and solar disturbing forces must deflect the apparent vertical, and it was sought to measure this effect by a pendulum. The quantities to be determined are so excessively minute, and the other disturbing forces so difficult to eliminate, that the method was only carried out successfully by Hecker in 1907, and subsequently by Orloff in Russia. The results on the whole were to the effect that the observed deflections were about three-fifths of what they ought to be if the earth were perfectly unyielding ,and were so far in accordance with estimates previously made by Darwin and others, from the somewhat imperfect statistics of the fortnightly tide. There was, however, a discrepancy between the results deduced from the deflections in the meridian and at right angles to it, which gave rise to much perplexity. The question was finally set at rest by Michelson in 1916. He conceived the idea of measuring the tides produced in two canals (really two pipes half filled with water) of about 500 feet long, extending one N. and S., the other E .and W. These tides are, of course, of a microscopical character, their range is of the order of one-hundredth of a millimetre, and they could only be detected by the refined optical methods which Michelson himself has devised. The observations, when plotted on a magnified scale, exhibit all the usual features of a tide-gauge record, the alternation of spring and neap tides, the diurnal and semi-diurnal lunar tides, and so on. The theoretical tides in the canals can, of course, be calculated with great ease, and the comparison led to the result that the ratio which the observed

tides bore to the theoretical was about .69, being practically the same in both cases. The whole enterprise was as remarkable for the courage of its inception as for the skill with which it was carried out, and was worthy of the genius which has accomplished so many marvels of celestial and terrestrial measurement. The perplexing discrepancy in the results obtained by Hecker at Potsdam is no doubt to be explained by the attraction of the tidal waters in the not very remote North Sea, and by the deformation due to the alternating load which they impose on the bottom. In Chicago, near the centre of the American continent, these influences were absent.

The question may be asked, what is the precise degree of rigidity which is indicated by these observations, or by others which have been referred to? Various answers have been given, based on observations of the tides, or the lunar deflection of the vertical, and of the period of the earth's Eulerian mutation, on which I have not touched. The estimates have varied greatly, but they are all high, some of them extremely high. That they should differ among themselves is not surprising. The material is certainly not uniform, either in its elastic properties or the conditions to which it is subject ,so that we can only speak of the rigidity of the earth as a whole in some conventional sense. Larmor and Love have shown that all the information that can be gathered, whether from the tides or from the Eulerian mutation, can be condensed into two numerical constants. This leaves a large degree of indeterminateness as to the actual distribution of elasticity within the earth. It is at all events certain that in regard to tidal forces the great bulk of the material must be highly rigid.

(*To be continued.*)

ASIATIC SOCIETY OF BENGAL.

Volume XX., new series, No. 3, 1924, of the Proceedings, is devoted to the development of the Hadish Concordance in Arabic literature, while No. 4 is a numismatic number, dealing with the coinage struck for the British East India Company's settlement of Penang (1786-1828), with several photos.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

208,92.--Everest ,A. E.--Manufacture of nitro-deriatives of aromatic amines. August 13th.

20,364.—Hodgson, H. H.- Manufacture of chloro- and nitro-chloro-derivatives of metal-hydroxybenzaldehyde. August 13th.

20,484.—Soc. des. Etablissements Barbet. —Rectification of acetic acid. August 14th.

20,403.—Stoltzenberg, H.—Production of coupling compounds of hydrocyanic acid and metal chlorides. August 15th.

Specifications Published this Week.

237,081.—Slate ,T. B.--Method of and apparatus for converting carbon dioxide into a solid.

237,088.—Maxted, E. B., and Coke, B. E. —Processes for the oxidation of derivatives of aromatic hydro carbons.

237,716.—Legeler, Dr. E.- -Process for producing carbon disulphide.

221,209.—Jacobson, R.- Method of pro ducing pure alumina.

Abstract Published this Week.

236,086.—Formaldehyde.—Kaiser, K., 32, Kastanienallee, Westend, Berlin.

In the catalytic oxidation of methane to formaldehyde, the metal oxide or hydroxide employer as catalyst is mounted upon a carrier. The carier, which may be any inert body such as pumice, is impregnated with a metal salt solution such as copper, iron, manganese or chromium sulphate solution and heated in a solution of say caustic alkali or carbonate to precipitate the metal oxide or hydroxide, or vice versa; or the inert body is soaked in a solution of salt, such as the nitrate, of the metal, which is then transformed by heat into the oxide. Alternatively, the inert body is impregnated with a colloidal solution of the metal oxide, and the gel either precipitated by heat or as the result of a previous impregna

tion with an alkali carbonate or other substance adapted to precipitate metal oxide sols as gels. An example is given of the production of formaldehyde using pumice stone impregnated with a mixture of iron oxide and chromium oxide or hydroxide.

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The Latest TRADE MARKS

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CELLUGLOS.

459,764.—Chemical substances used in the manufacture of liquid celluloid enamel.—Urice and Sons, Ltd., 10 to 20, Fitzroy Place, Euston Road, London, N.W.1. August 19th, 1925.

BISGLUCOL.

460,418.—Chemical substances prepared for use in medicine and pharmacy.—May and Baker, Ltd., Garden Wharf, Church Road, Battersea, London ,S.W.1. August 19th, 1925.

COLLINON.

458,094.—Chemical substances prepared for use in medicine and pharmacy.—Koholyt Aktiengesellschaft, Potsdamerstrasse 75, Berlin, W. 57, Germany. August 19th, 1925.

The above Marks have been "accepted" by H.M. Patent Office, and unless any objection is lodged, the Marks will be duly Registered They are, however, officially advertised for opposition, which must be lodged within one month from date quoted. All particulars and forms for opposition will be sent free by Messrs. Rayner and Co., 5, Chancery Lane, London.

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GOVERNMENT CHEMIST.

REPORT OF THE GOVERNMENT CHEMIST UPON THE WORK OF THE GOVERNMENT LABORATORY FOR THE YEAR ENDING 31ST MARCH, 1925, WITH APPENDICES.

The chemical work of the following Departments is performed wholly or in part in the Government Laboratories:—Admiralty; Ministry of Agriculture and Fisheries, Air Ministry, Colonial Office, Crown Agents for the Colonies, Board of Customs and Excise, Geological Survey, Ministry of Health, Board of Inland Revenue, Ministry of Pensions, Post Office, Department of Scientific and Industrial Research, Home Office, Board of Trade, War Office, Office of Woods and Forests, Privy Council, and Office of Works.

The work for most of these departments is carried out at the laboratory at Clement's Inn Passage. The laboratory at the Custom House, London, deals especially with Customs samples, while the chemical stations, to which reference is made in connection with the work for the Board of Customs and Excise, deal with Customs samples and some Excise samples. In addition, the Department maintains the laboratory in the Geological Survey Museum for the analysis of ores for the Survey, and carries out the inspection of food stores and supplies for the War Office at the Supply Reserve Depot, Deptford, where also there is a laboratory.

The total number of samples examined in the course of the year, including those dealt with at the chemical stations, is 448,106, as compared with 390,421 in the preceding year, an increase of 57,685. There has been an increase of 23,457 in the number of samples examined at the chemical stations, while the number examined at the central laboratories in London has risen from 251,009 to 285,237, an increase of 34,228. The samples of wine have increased from 92,319 to 116,547; of sugar from 55,887 to 58,310; and of tea from 42,068 to 58,022; while there are notable increases in the number of samples of exported beer, cocoa products, and imported spirituous preparations. The number of samples of beer for the detection of dilution is 4,092, being nearly 1,000 below the number in the previous year. The number of samples of exported tobacco and snuff has fallen from 17,718 to 13,162. The decrease is due to the cessation of large exports to the Irish Free State, and would have been greater if it had not been counterbalanced to a large extent by an increase in exports to other countries. The samples of offal tobacco have increased from 36,022 to 39,731. The work in connection with the Safeguarding of Industries Act has involved the examination of nearly 10,000 samples. The Dangerous Drugs Act and the Dyestuffs (Import Regulation) Act still impose considerable work on the Department, and many Departments of the Crown have continued to seek the services of the laboratory, in some cases to a considerably greater extent than in previous years.

ADMIRALTY.

Chemical work is performed for the Admiralty in connection with the contract department,, the naval yards, the engineering department and the hospitals. The contracts branch submitted 58 samples of food on tender for report as to conformity with specification and opinion as to relative merits. The technical examining officers at the victualling yards forwarded 252 samples from supplies for examination and report, many of the samples being submitted with the object of preventing the issue of canned goods contaminated with metals.

Other samples to the number of 75 included 'soaps, tin plates, gold braid and hempen cords.

In addition to the examination of the

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foregoing samples of foods and general stores, the determination of the salinity of 1,413 samples of sea-water was carried out for the Admiralty.

Ministry of Agriculture and Fisheries.

The samples examined for the Ministry of Agriculture and Fisheries and the Board of Agriculture and Fisheries for Scotland may be classified as follows:

(1) Imported dairy produce and margarine.
(2) Butter and margarine taken at factories.
(3) Sheep dips.
(4) Water and pollution or rivers.
(5) Sea water.
(6) Substances under the Fertilisers and Feeding Stuffs Act.
(7) Substances under the Merchandise Marks Act.
(8) Miscellaneous articles.

For the Government of Northern Ireland 14 samples taken by Customs Officers from imported dairy produce were examined. The numbers are included in those given below.

(1) *Imported Dairy Produce and Margarine.*—The Sale of Food and Drugs Act, 1899, the Butter and Margarine Act, 1970, the Milk and Cream Regulations ,1912, and the Public Health (Condensed Milk) Regulations, 1923, impose certain restrictions on the importation of butter, milk, cream and margarine. For example, it is an offence to import butter and margarine containing more than 16 per cent. of water; or margarine containing more than 10 per cent. of butter fat; or adulterated or impoverished milk and cream; or condensed milk which does not conform to certain standards, and which is not contained in receptacles labelled according to regulations. To ascertain whether these provisions are complied with, Officers of Customs take samples from consignments at the port of entry for analysis at this laboratory.

INSULATION FOR REFRIGERATORS.

The Best Practical Non-Conductor of Heat.

By A Well-Known Engineer.

The question of practical heat insulation in the case of refrigeration and general low temperature work has been an interesting problem from a chemical point of view, and the final solution is the use of granulated cork first pressed into sheets and then baked.

Merely considered from heat non-conductivity, all kinds of substances could be employed to line the inside of the chambers, such as sawdust, charcoal, slag wool, cork, hair felt, magnesium carbonate, paper, asbestos, and even wood. Under practical refrigerating conditions, however, other factors enter into the case, such as mildew or dry rot, absorption of moisture, the tendency of the material to move or get out of position, and the risk of fire. Sawdust, charcoal, and slag wool were at one time exclusively employed, but the main difficulty with sawdust, for example, is that it easily absorbs moisture, and not only is its non-conductivity to heat thereby seriously reduced, but at the same time dry rot starts up. Charcoal also readily absorbs moisture, and is dangerous because of its liability to spontaneous combustion, whilst as regards slag wool, which in itself is an absolutely fireproof efficient non-conductor of heat and does not take up much moisture, the difficulty is that when it is packed in the compartments it begins to settle down by gravity and vibration, leaving the top portion partially exposed and therefore reducing the efficiency of refrigeration. If now, attempts are made to get over this by "tamping" the material, the fibres are broken and the non-conductivity decreased.

For these various reasons cork is to-day almost universally employed, and is in the first place an almost ideal non-conductor of heat, being, of course, the natural production of the tree. The earlier attempts to use granulated cork in such a matter that it could not alter its position, consisted in mixing with asphalt, bitumen, or other mat material, and then compressing into sheets. The disadvantages, however, of this method are the increased risk of fire, the slight reduction in the heat insulating properties, and the tendency of the food to be tainted by the smell.

Compression into sheets, followed by baking, gets over all these troubles, and, in fact, still further improves the non-conductivity by the decomposition of all the volatile matter present, whilst the absence of moisture eliminates any slight tendency to mildew. For further information on this subject, we should recommend a perusal of a paper read before the International Congress of Refrigeration at the Institution of Mechanical Engineers on une 17, 1924,

by Mr. James Hatton, A.M.I.Mech.E., who, it may be mentioned, is a director of Messrs. Sutcliffe Bros., and Bryce, Ltd., of Hyde, near Manchester, specialising on heat insulation work for both high and low temperatures. There is also contained some interesting information on the lagging of refrigerator pipe circuits, a subject that has been somewhat neglected. Here again, granulated cork sectional covering is the best, finished off either with cement or canvas, the hair felt often employed being a much inferior material, which, in addition to other disadvantages, harbours vermin.

RECLAMATION OF GASOLINE USED IN DRY CLEANING.

By C. C. Hubbard.

(Bureau of Standards, U.S.A.)

The author outlines and discusses briefly the processes that have been used in the dry-cleaning industry for the "purification" and recovery of gasoline from the material that has become dirty in use. Results are reported of experimental studies in the laboratory and in dry-cleaning plants and of large-scale tests in dry-cleaning plants, using activated carbon and an aqueous solution of trisodium phosphate. A process is recommended for the rapid and economical purification and recovery of gasoline in large or small plants. The salient features of this process are treatment of the solvent with activated carbon and an aqueous solution of trisodium phosphate, definite time of agitation, definite temperature range, settling, and finally decantation of the colourless, recovered solvent. The process also provides for the recovery of the gasoline retained by the sludge.

AN IMPROVED TYPE OF WAVE METER RESONANCE INDICATOR.

By Morris S. Strock.

(Bureau of Standards, U.S.A.)

A resonance indicator as used on most portable wave meters commonly consists of a "thermogalvanometer" connected in series in the tuned circuit of the wave meter. The use of this instrument reduces the precision of setting the wave-meter condenser, because it adds to the resistance of the wave meter and because it gives comparatively small resonance deflections at low settings of the condenser.

This paper describes a resonance indicator for a portable wave meter which can be used in place of the thermogalvanometer. It gives an approximately uniform resonance deflection over the frequency range of the wave meter, does not appreciably increase its resistance, and is more sensitive than the thermogalvanometer. The method employs a sensitive milliammeter and a crystal detector connected in such a manner that a combination of capacitive and inductive coupling is obtained with respect to the wave-meter circuit.

The operation of a wave meter equipped with this device is not quite as simple as the operation of a wave meter equipped with a thermogalvanometer, because it requires an adjustment of the crystal detector. However, if the detector is of good mechanical design and is provided with a crystal of uniform sensitivity this is not a great drawback. Experimental data are given to show that this method of resonance indication permits precise settings of the wave-meter condenser. The resonance indicator may be added to most portable wave meters in greater precision in their use.

A description has been given of a resonance indicating device for a portable wave meter which can be used to replace the thermogalvanometer. This device employs a crystal detector and milliammeter connected in such a manner that a combination of capacitive and inductive coupling is seured. It gives an approximately uniform resonance deflection throughout the frequency range of the wave meter, is more sensitive than the thermogalvanometer, and increases the precision of the wave meter. Tests have shown that this method of resonance indication is reliable.

The operation of a wave meter equipped with this resonance indicator is slightly less simple than that of a wave meter equipped with a thermogalvanometer.

SAND LIME BRICKS.

An Interesting Installation in Sussex.

(From a Correspondent.)

It has always been a curious fact that the highly scientific and efficient method of brick-making by the sand lime or calcium silicate process has made such little progress in Great Britain, in spite of the

enormous developments on the Continent and in America, the world production to-day being over 2,500,000 sand lime bricks per annum. However, we are at last beginning to realise the importance of the matter and to the very few plants operating in Great Britain there has now been added a fine new installation, on the latest principles, recently started up at Littlehampton in Sussex, by Messrs. The Arun Brick Co., Ltd. This has a capacity of 110,000 to 120,000 bricks per week and the plant and equipment has been supplied complete by Messrs. Sutcliffe Speakman & Co., Ltd., of Leigh, Lancashire, who are one of the pioneers of the process and have erected many sand lime brick plants on the continent and, in fact, all over the world.

The process consists in mixing intimately sand with about 5-10% of its weight of finely powdered slaked lime, which contains no trace of quicklime, compressing the mixture into brick shapes in an automatic brick moulding machine or press, and then heating these shapes in a closed pressure steel cylinder or autoclave into which steam is blown at high pressure, giving an intensely hard brick, the chemical reaction being the formation of calcium silicate from the lime and the sand (silica), which binds the whole mass together into an intensely hard product.

At the Littlehampton plant the lump quicklime is passed through a crusher and then ground in a ball mill equivalent to all through a 50 mesh screen (50 holes to the linear inch, or 2,500 holes per square inch). The ground quicklime is subsequently mixed with the sand in the proportion of 5-10%, as already indicated, and allowed to lie for 12 hours in a silo or store bin, so that the natural moisture in the sand completely slakes the lime, leaving no trace of quicklime. It is curious that this process is an extremely delicate test for the presence of free lime in slaked lime, and accordingly no ordinary method of quick slaking can be employed because of the risk of free lime being present.

The mixture is then fed to a second grinding mill, which results in an absolutely smooth and even product, and passed into a powerful "Emperor" duplex brick press. In this the pressure is 2 tons per square inch—about 90 tons on the complete standard brick, 9 inches by 4¾ by 4¾—and the shapes are turned out at the rate of approximately 40 per minute. They are then stacked on small trolleys, each of which holds 300 bricks and 12 trolleys, one behind the other, that is, 3,600 bricks, are run on rails into a long steel boiler, which operates at 165 lbs. per square inch, corresponding to a temperature of about 370° F. The time required, because of this high pressure, is only 4 hours and the boiler is then opened and the train load of 3,600 bricks is run out at the other end ready for use. It is, of course, well-known that sand lime bricks are superior to the burnt clay product, and the British Engineering Standards Association, 28, Victoria Street, London, S.W.1, have now a standard specification (No. 187) for the manufacture and testing of sand lime bricks, whilst it may be stated building blocks, tiles and slabs for paving can be made by the same method.

General Notes.

OCCUPATIONS OF EMIGRANTS AND IMMIGRANTS OF BRITISH NATIONALITY.—GREAT BRITAIN AND IRELAND.

In the *Board of Trade Journal* of 26 March (pages 340-345), particulars were given of the Passenger Movement from and to the United Kingdom (Great Britain and Northern Ireland) in 1923 and 1924, and also of the numbers of British migrants in those years, distinguishing male and female adults of 12 years of age and upwards and children under 12. Comparative particulars of the passenger movement and migration from and to the Irish Free State in the nine months April to December, 1923, and in the year 1924 were published in the *Journal*, dated 30 April (pages 471-473). The figures in respect of the ocupations of emigrants immigrants of British nationality which appear in the following tables relate to the numbers who left ,or arrived in, the British Isles (*i.e.*, Great Britain, Northern Ireland and the Irish Free State). Corresponding particulars for the years 1921, 1922 and 1923 were published in the *Journal* dated 28 August, 1924 (pages 230-234).

"Adults" are classified in the statutory passenger returns as persons of 12 years of age and upwards, in accordance with the requirements of the Merchant Shipping Acts, but for the purpose of occupational classification the minimum age for an "adult" worker has been taken as 18

years. Since 1921 the occupations recorded as folowed by British emigrants and immigrants of 18 years of age and over have been classified in ten groups for males and six groups for females, and the results for 1924 are shown in detail in the tables which follow.

The first table shows the number of British migrants included in these occupational groups and the total number of "statute adults" in 1922, 1923, and 1924; the differences between the respective totals would be made up to a large extent by persons of school age and by others not in settled occupations :—

British Subjects.	Emigrants from the British Isles. 1922.	1923.	1924.	Immigrants into the British Isles. 1922.	1923.	1924.
Males—						
Total number of adults of 12 years and upwards ..	77,073	141,027	77,552	25,851	23,066	28,570
Adults of 18 years and upwards	70,272	130,188	68,931	24,742	22,126	27,422
Females—						
Total number of adults of 12 years and upwards ...	70,816	89,884	68,354	29,518	25,025	26,630
Adults of 18 years and upwards	65,753	82,721	62,933	28,161	23,807	25,421

The striking decline in the number of emigrants in 1924 as compared with 1923 has already been noted in the *Journal* of 26 March. From the above table it will be seen that the biggest proportional decrease occurred among male adults of 18 years and upwards, the number of such emigrants being 68,931 in 1924 against 130,188 in 1923. Of the decline in this group the United States accounted for 42,391, the number in 1924 being 9,430 against 51,821 in 1923, and the British Empire for 18,872, the number in 1924 being 56,584 against 75,456 in 1923.

It will be seen from the table that the emigrants of 12 to 17 years of age averaged about 9 per cent. of the aggregate number of males and about 8 per cent. of the aggregate number of females during the three years 1922 to 1924; of the immigrants 4.1 per cent. of the males and 4.7 per cent. of the females were in the age group 12 to 17. In connection with the number of migrants to and from the British Isles in 1923 and 1924 it should be noted that, although the Irish Free State ceased to be a portion of the United Kingdom from 1st April, 1923, the particulars shown throughout in these tables include the number of migrants to and from the Free State for the whole of 1923 and 1924, and are comparable with those for 1922. They differ, accordingly, from the figures in respect of United Kingdom migration in 1923 and 1924, to which reference has been made in the first paragraph.

The summary table shows that in each of the three years under consideration the number of male emigrants from the British Isles whose occupations were returned as agricultural exceeded the number in any other individual group; the percentage in this group rose from 18.4 of the total males of 18 years and upwards in 1922, to 20.1 in 1923, and to 27.5 in 1924. The decreased movement to the United States in 1924, as compared with 1923, was no doubt responsible for the reduction in the numbers recorded as engaged in skilled trade. The most noticeable decrease is shown in the metal and engineering group, which accounted for 19.0 per cent. of the total males in 1923 and only 11.2 per cent. in 1924. The percentages employed in mining and quarrying and in building also decreased in 1924 as compared with 1923. The proportion of skilled workers, other than those employed in the industries mentioned above, fell from 13.0 per cent. of the total in 1923 to 10.0 per cent. in 1924. In the commercial, finance and insurance group and in the professional group proportional increases were shown in 1924 as compared with 1923, the percentage in the former group rising from 10.0 to 13.7, and in the latter from 3.4 to 5.5. Labourers who did not describe themselves as engaged in agriculture or transport accounted for about 10 per cent. of the total in 1922 and 1924, and for 14.6 per cent. in 1923. The proportion in the transport and communications group showed little variation in the

three years. Other and ill-defined occupations, not included in the preceding groups, accounted for about 12 per cent. of the totals in 1922 and 1924, and for 8 per cent. in 1923. Of the female emigrants the number of wives or housewives (not otherwise described) amounted to nearly one-half of the total in each of the three years. The percentage employed in domestic, hotel, etc., service was 27.4 in 1922, 28.5 in 1923, and 29.9 in 1924. Little relative variation is shown in the other groups.

THE WORLD'S LARGEST INSTITUTION FOR THE BLIND.

The annual report of the National Institute for the Blind (Headquarters: 224-6-8, Great Portland Street, London, W.1.), for the financial year ended March 31, 1925, affords a unique insight into that strange world of the blind which is so remarkable in its interest yet so difficult to comprehend.

If a comparison is made between this document and the report, say, of any institution for the blind fifty years ago, one is astonished at the marvellous progress which has been made in all ameliorative work for the blind. In the words of the report, the outstanding quality of the blind is courage, and courage should characterise all work connected with them. It is this spirit which has made the National Institute the largest institution for the blind in the world.

Last Year's Work.

During the year under review allocations amounting to over £86,000 were made to local institutions for the blind; over 316,000 volumes, magazines, newspapers, etc., in Braille and Moon types, were produced; over 10,300 music volumes and pamphlets were published; publications were sold to the blind at a very considerable reduction of cost, the value of these reductions, together with that of gifts ,amounting to over £8,300; over £6,800 was distributed in relief; educational and training fees amounting to over £1,500 were paid; over £53,000 was expended in salaries, wages, etc., to blind employees; over 37,000 visits were made to the blind by home teachers.

AUSTRALIA.

Tenders Wanted.

Sulphate of Copper. Schedule No. C.15.

His Majesty's Senior Trade Commissioner in Australia (Mr. R .W. Dalton), reports that the Postmaster-General's Department, Melbourne, are calling for tenders to be presented by the 6 October, for sulphate of copper.

A copy of the schedule and general conditions of tender is available for inspection by British firms interested, at the Department of Overseas Trade (Room 52), 35, Old Queen Street, London, S.W.1.

SOAP FOR SOUTH AFRICA.

The Office of His Majesty's Senior Trade Commissioner in South Africa reports that the Administration of the South African Railways and Harbours is inviting tenders for the supply of soap as required during the period 1 January, 1926, to 30 June, 1926.

United Kingdom firms desiring further particulars of this call for tenders should apply to the Department of Overseas Trade, mentioning reference number B.X.2006. 35, Old Queen Street, London, S.W.1.,

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Southampton, 1925.

The annual meeting was held from August 26 to September 2.

THE PRESIDENTIAL ADDRESS.

By Professor Horace Lamb, Sc.C., LL.D., F.R.S., (President of the Association).

(Continued From Last Week.)

In leaving this topic, it may be recalled that it was in this same connection that Kelvin was led to initiate the method of Harmonic Analysis as applied to the tides, as well as to accomplish much brilliant mathematical work, whose importance is by no means limited to the present subject. The whole theory of the tides and cognate cosmical questions afterwards became the special province of George Darwin, but after his death, work on the tides was almost at a standstill ,until it was resumed by Professor Proudman and his associate Dr. Doodson in the recently established

Tidal Institute at Liverpool. They have already arrived at results of great theoretic as well as practical interest, some of which I understand are to be brought before the Association at this meeting.

Within the last twenty years or so, light has come on the elastic properties of the earth from a new and unexpected quarter, *viz.*, from a study of the propagation of earthquake shocks. It is pleasant to recall that this has been largely due to efforts especially fostered, so far as its means allowed, by this Association. To John Milne, more than to anyone else, is due the inception of a system of widely scattered seismological stations. The instruments which he devised have been improved upon by others, notably by Galitzin, but it is mainly due to his initative that we are indebted for such insight as has been gained into the elastic character of the materials of the earth, down, at least, to a depth of half the radius. It may be remarked that the theory of elastic waves, which is here involved, was initiated and developed in quite a different connection, in the persistent but vain attempts to construct a mechanical representation of the luminiferous ether which exercised the mathematical physicists of a generation or two ago. It has here at length found its natural application. One of the first problems of seismologists has been to construct, from observation, tables which should give the time an elastic wave of either of the two cardinal types—*viz.*, of longitudinal and transverse vibration—takes to travel from any one point of the earth's surface to any other. It has been shown by Herglotz and Bateman that if these data were accurately known it should be possible, though naturally by a very indirect process, to deduce the velocities of propagation of the two types throughout the interior. Such tables have been propounded, and are in current use for the purpose of fixing the locality of a distant earthquake when this is not otherwise known. They are, however, admittedly imperfect, owing to the difficulty of allowing for the depth of the focus, which is not always near the surface, and is sometimes deep-seated. This uncertainty affects, of course, the observational material on which the tables are based. Some partial corrections have been made by Professor Turner, who almost alone in this country, amidst many distractions, keeps the study of seismology alive, but the construction of accurate tables remains the most urgent problem in the subject. Taking however the material, such as it is, the late Professor Knott, a few years ago, undertook the laborious task of carrying out the inverse process of deducing the internal velocities of the two types of waves referred to. Although it is possible that his conclusions may have to be revised in the light of improved data, and, it may be, improved methods of calculation, they appear to afford a fairly accurate estimate of the wave velocities from the surface down to a depth of more than half the earth's radius. Near the surface the two types have velocities of about 7.2 and 4 km. per second, respectively. These velocities increase almost uniformly as we descend, until a depth of one-third the radius is reached, after which, so far as they can be traced, they have constant values of 12.7 and 6.8 km. per second, which, by the way, considerably exceed the corresponding velocities in iron under ordinary conditions. The innermost core of the earth, *i.e.*, a region extending from the centre to about one-fourth of the radius, remains somewhat mysterious. It can certainly propagate condensational waves, but the secondary waves are hard to identify beyond a distance of 120° of arc from the source of disturbance. Knott himself inferred that the material of the central core is unable to withstand shearing stress, just as if it were fluid, but this must at present remain, I think, uncertain.

It should be remarked that the wave-velocities by themselves do not furnish any information as to the elasticities or the density of the material, since they involve only the ratios of these quantities. The relation between the two velocities is however significant, and it is satisfactory to note that it has much the same value as in ordinary metals or glass.

It is to be regretted that at present so little is being done in the way of interpretation of seismic records. Material support in the way of more and better equipped stations is certainly needed, but what is wanted above all is the co-ordination of such evidence as exists, the construction of more accurate tables, and the comparative study of graphical records. These latter present many features which are at present hard to interpret, and a systematic comparison of records of the same earthquake with standardised instruments, should lead to results of great theoretical interest. The task will be a difficult one, but until it is

accomplished we are in the position of a scholar who can guess a few words in an ancient text, possibly the most significant, but to whom the rest is obscure.

Even on this rapid review of the subject, it should be clear that there is an apparent inconsistency between the results of two lines of argument. On the one hand, the thermal evidence points to the existence of a high temperature at a depth which is no great fraction of the earth's radius, so high indeed as to suggest a plastic condition which would readily yield to shearing stress. On the other hand, the tidal arguments, as well as the free propagation of waves of transversal vibration at great depths, indicate with certainty something like perfect elasticity in the mathematical sense. The material with which we are concerned is under conditions far removed from any of which we have experience; the pressures, for instance, are enormous; and it is possibly in this direction that the solution of the difficulty is to be sought. We have some experience of substances which are plastic under long-continued stress, but which behave as rigid bodies as regards vibrations of short period, although this combination of properties is, I think, only met with at moderate temperatures. It is conceivable that we have here a true analogy, and that the material in question, under its special conditions, though plastic under steady application of force, as for instance centrifugal force, may be practically rigid as regards oscillatory forces, even when their period is so long as a day or a fortnight. But beyond that we can hardly, with confidence, go at present.

I have chosen the preceding subject for this address, partly because it has not recently been reviewed at these meetings, and also for the opportunity it has given of urgin gone or two special points. It is evidently far from exhausted—the loose ends have indeed been manifest—but this should render it more interesting. It furnishes also an instance, not so familiar as some, of the way in which speculations which appear remote from common interests may ultimately have an important influence on the progress of science. It is true that the secular investigations into the form of the earth's surface have an importance in relation to Geodesy, but certainly no one at the time of Laplace's work on this matter would have guessed that he was unwittingly laying the foundation of the whole mathematical theory of electricity. The history of science is indeed full of examples where one branch of science has profited by another in unexpected ways. I would take leave just to mention two, which happen to have specialy interested me. It is, I think, not generally understood what an important part the theory of elasticity played in Rayleigh's classical determinations of the relative weights of the gases, where it supplied an important and indeed essential correction. Again, the mathematical theory of Hydrodynamics, in spite of some notable successes, has often been classed as a piece of Pure Mathematics dealing with an ideal and impossible fluid, elegant indeed, but helpless to account for such an everyday matter as the turbulent flow of water through a pipe. Recently, however, at the hands of Prandtl, it has yielded the best available scheme of the forces on an aeroplane, and is even being appealed to to explain the still perplexing problem of the screw-propeller.

To promote this interaction between different branches of science is one of the most important functions of our Association, and differentiates it from the various sectional congresses which have from time to time been arranged. We may hope that this meeting, equally with former ones, may contribute to this desirable end.

Let me close with a local reference. The last fifty years have seen the institution of local universities and university colleges in many parts of this country and of the Empire at large. Through these agencies the delights of literature, the discipline of science, have been brought within the reach of thousands whose horizons have become enlarged and their whole outlook on life transformed. They have become centres, too, from which valuable original work in scholarship, history, and science has radiated. The University College of Southampton is now contemplating an increased activity and a fuller development. In this ambition it has, I am sure, the best wishes of us all."

Section B.—Chemistry.

THE CHEMISTRY OF SOLIDS.

Address by Professor Cecil H. Desch, D.Sc., Ph.D., F.R.S., President of the Section.

"In entering on the task of delivering an address from this chair, my predecessors have often selected a special topic for

consideration, but have prefaced their remarks by a glance at the general position of chemistry at the time. This precedent I propose to follow, in the belief that it is well for us to give attention now and then to the relations of chemistry to the great body of science as a whole. Two tendencies are clearly visible, and are profoundly affecting our methods of study and instruction, and also the direction of research. On the one hand, chemistry, like every other science, is being split up into a number of distinct specialisms, and workers are tempted, or even compelled to confine themselves to a narow field; on the other, the boundaries betwen the several sciences are becoming less definite, through the development of border sciences, which themselves become new specialisms. In so far as it is possible to arrange the abstract sciences in a linear series, chemistry may be said to depend upon physics, as the biological sciences in their turn depend upon chemistry, the theoretical part of each being built up on the established laws of the preceding science as a basis. Physics has gone far to provide the required basis for chemistry, and each new advance in physics suggests new ideas in chemistry. Chemistry in its turn is providing a basis for biology, although more slowly than had been hoped. Great as have been the triumphs of organic synthesis and of investigations of the colloidal state, the chemical study of living organisms is still looking to chemistry for more help than it has yet received. It is in this field that we may hope for the greatest advances in the near future, as the importance of a sound chemical foundation for biological science is more clearly recognised.

Whether we look at the serious publications dealing expressly with the progress of science or at the mass of popular articles in newspapers and periodicals, we see that the centre of interest at the present day lies in the new discoveries and hypotheses of physics. Leaving aside the practical applications of physical science, such as the improvement of wireles comunication, which absorb the greater part of the popular interest, there is no question but that the structure of the atom, the theories of relativity and of quanta, the existence of the ether, and the results of the examination of crystals by means of X-rays, interest the educated public more deeply than any questions in chemical or, probably, in biological science, whilst some of them are even found useful by journalists in search of sensation. On the other hand, there is little public curiosity in regard to the advance of chemical science. A few of its applications, and those mainly concerned with warfare, attract attention from time to time, although the progress of agricultural chemistry, the most important of all from a national point of view, is shamefully neglected, in spite of the admirable work which is being done at Rothampsted and elsewhere. The public interest in chemistry does not extend far beyond poison gases and dyes. The progress of pure chemistry and the development of chemical theory are only followed by a small body of specialists, engaged in teaching or research, and of students whom our present system of scholarships and degrees forces more and more to become specialists, even at a very early stage of their studies. Perhaps this state of things is responsible for a certain attitude concerning the future of chemistry which may be traced, in implication rather than expresion, in the work of some chemists at the present day. It appears to be thought that chemistry is fated to become a branch of physics, and thus to lose its own peculiar discipline, leaving its long-established methods to chemists engaged in operations of a routine character, whilst new knowledge is being acquired by the application of physical methods of experiment, and interpreted by the methods of mathematical physics. The knowledge of the internal structure of the atom, and consequently of the manner in which atoms may unite chemically with ont another has advanced with such extraordinary rapidity that it has seemed that chemical facts must henceforth be regarded in an entirely new light. If we accept the view, for which such strong evidence has been produced, that protons and electrons are the units of which all atoms are composed, the forces between them being purely electrical, and that the whole system of the chemical elements may be built up in a perfectly regular and systematic fashion from these units, whilst the structure of each atom enables us to predict how it will enter into combination with other atoms, then it would seem that chemistry should in course of time become a purely deductive science, the properties of compounds being deduced from the number and arrangement of their component atoms, due note being taken of the changes of energy during their formation, such changes of energy being them-

selves accounted for by the exchange of electrons. Such a conception of chemistry recalls the views which were held some fifty years ago as to the mechanical structure of the universe. Kirchoff spoke of the aim of natural science is being ' the reduction of all the phenomena of nature to mechanics,' and Helmholtz declared that ' the object of the natural sciences is to find the motions upon which all other changes are based, and their corresponding motive forces—to resolve themselves, therefore, into mechanics.' Writers of the time made it clear that the biological sciences were included in this generalisation. So simplified a view has lost ground in the course of the last half-century, and although the theoretical possibility of such a conception of science would probably find many defenders, it has been generally admitted that the unity of science is not best shown by attempts to reduce all its phenomena to those of a single kind. The acceptance of the modern view as to the structure of the atom has brought about something like a return to the position of the mechanical physicists of the nineteenth century. Mr. Bertrand Russell, following such ideas to their logical conclusion, says that: ' Physical science is approaching the stage when it will be complete, and therefore uninteresting. Given the laws governing the motions of electrons and protons, the rest is merely geography-- a collection of particular facts telling their distribution throughout some portion of the world's history. The total number of facts of geography required to determine the world's history is probably finite; theoreticaly, they could all be wrtten down in a big book to be kept at Somerset House, with a calculating machine attached, which, by turning a handle, would enable the inquirer to find out the facts at other times than those recorded. It is difficult to imagine anything les interesting, or more different from the passionate delights of incomplete discovery.'

If such a state of things were to come about, experiment in chemistry would be unnecessary, since all facts could be deduced from certain general principles and from fundamental physical constants which would by then have been determined with great accuracy. Of course, no person believes that such conditions will ever be attained, and the passage quoted above is only a picturesque statement of the position that all science may, in the last degree, be considered as mechanics. Chemists, however, know that this is not how their science has advanced or is likely to advance. Chemistry is an experimental science, which progresses by the application of a definite discipline, obtaining conclusions by induction from the observed facts, and making use of deductions from a small number of well-tried hypotheses where required. Granting the theoretical possibility that atomic theory might become so perfect that molecules might be deduced from a comparatively limited mass of data, it would nevertheless remain true that the labour of such deduction would be beyond human powers, except in relatively simple cases. We can scarcely imagine the properties and synthesis of indigo being deduced from the internal structure of the atoms of carbon, nitrogen, oxygen, and hydrogen, although it is posibly true that the one is implicit in the other. Human intelligence is not equal to the task, not does it seem likely to be so in the future. Chemistry must continue to go its own way, whilst making every use of the new physical conceptions as an aid in generalisation and as a means of co-ordinating facts. There need be no fear that it will cease to have a separate existence.

Chemical science has been responsible for the introduction of a number of hypotheses which have survived to the present day, and it may be worth while to look at them for a moment, although they are familiar to all and attention has been directed to them by recent writers. The doctrine of atoms, as we all know, was not a chemical invention, but there is a vast difference between its use among Greek philosophers as a means of satisfying their desire to find a consistent explanation of the universe and its scientific application in the hands of Dalton as a means of explanation of the quantitative facts of chemical combination. There has been some discussion as to Dalton's personal attitude on this question, but there can be no doubt that those who did most to establish the doctrine attached no metaphysical importance to it, but used it frankly as an hypothesis to explain known facts and, above all, to predict new facts. For instance, Kekulé said in 1867: ' The question whether atoms exist or not has but little significance from a chemical point of view; its discussion belongs rather to philosophy. In chemistry we have only to decide whether the assumption of atoms is an hypothesis adapted to the explanation of chemical phenomena . . . and to advance our knowledge of the mechanism of

chemical phenomena,' and it is probable that throughout the nineteenth century it was a matter of comparative indifference to most scientific chemists whether atoms had a real existence. All that was important was that matter behaved as though it had an atomic structure, and that no fallacies or errors were introduced by making such an asumption. The value of the atom to them was quite independent of any possible demonstration of its real existence. Gradually ,as the conception of atoms and mole cules was found to fit a larger and larger field of facts, confidence grew, and atoms came to be regarded as real, in the only sense in which the scientific experimenter can understand reality. Molecules, built up of atoms according to well-established laws, shared in this confidence, which was thoroughly justified by the remarkable concordance of the determinations of Avogadro's number, the number of molecules in the gramme molecule of a substance, as arrived at by a number of totaly independent methods. The discovery of radioactivity, whilst enlarging the conception of the atom, has made is possible to isolate the effects of single atoms travelling at a high velocity, so that the impact of a single α-ray on a fluorescent screen produces a visible effect, and the counting of these rays, which are known to be charged helium atoms, corresponds perfectly with the original hypothesis. When the minuteness of the atom was realised, chemists cannot have dreamed that a day would come when the effect of so extraordinarily minute a particle could be perceived by the eye and even exhibited on a screen to an audience. No more extraordinary confirmation of the soundness of the theoretical views of the chemists of the early nineteenth century could have been received.

It is strange to remember that little more than twenty years ago it was proposed by Franz Wald, and the idea was adopted by some chemists, that the atomic conception might be dispensed with in chemistry, and that the science might advance by making use of thermodynamical conceptions alone. It is certain that such a proposal could not have been made by an organic chemist, to whom reasoning on structural lines is habitual. It has been said that the establishment of the structural formula of an organic compound of some complexity, such as an alkaloid or a triphenylmethane dye, by successive, carefully chosen steps of analysis and synthesis, is the best illustration of the principles of scientific reasoning, and there is much truth in the contention. Chemists, therefore, were not inclined to follow so illusory a path, and the proposal has met with no acceptance. The later development of chemistry has been entirely in the opposite direction, that of leaning with greater and greater confidence on the atomic and molecular foundations of the science.

Next came the development of structural theory ,with reference to organic compounds, associated with the names of Kekule, Couper, Crum Brown and Butlerow. Again the assumed arrangements of atoms in compounds were adopted in order to express the reactions of the substances, without reference to the real existence of the chains of atoms represented in the new formulæ. In 1867 Crum Brown wrote : 'While there can be no doubt that physical research points to a molecular constitution of matter, it is perfectly indifferent to a chemist whether his symbols represent atoms or units; and graphical formulæ would be as useful as they are now, were it conclusively proved that matter is continuous.' Within the last few years the study of the films of fatty acids and similar substances on the surface of water by Langmuir, Hardy and Adam has shown that the properties of such films can only be accounted for by assuming the reality of those chains of atoms which served so well the purposes of the chemist, but seemed physically improbable. The examination of solid fatty acids by means of X-rays leads to exactly the same conclusion. The greatest triumph of structural theory, the hexagon formula for benzene, need only be mentioned in passing, since it is only a month or two since the celebration of the discovery of benzene, by Faraday, when the wonderful chemistry of the aromatic compounds was eloquently described by Sir William Pope and Professor Armstrong. Next came the generalisation known as the periodic system of the elements, due mainly to Mendeleef and to Lothar Meyer, and finally the hypothesis of the tetrahedral arrangement of the atoms around a carbon atom, devised by van't Hoff and Le Bel to account for optical isomerism. Modern X-ray methods show that the structure of crystals of the corresponding substances is fully accounted for by assuming that the benzene hexagon and the tetrahedral linking of carbon are actually present, and the interpretation of crystals has been made

possible and unambiguous by the existence of so great a mass of fully established chemical data.

The point which I wish to make is that these hypotheses, of the chemical atom, of the molecule, of the chains and linkings represented in the graphic formulæ of organic compounds, of the hexagonal ring in aromatic substances, and of the tetrahedral carbon atom, were introduced without reference to any metaphysical conception of the nature of matter, and were independent of any dogma concerning reality; they were intended as working hypotheses, connecting and co-ordinating facts which had been discovered by the classical methods of chemical experimentation. That they have been confirmed by entirely independent physical means, so that they have become established as the truest representation we can have of nature, shows how sound was their foundation, and encourages us to suppose that the same methods which have served so well in the past may again be trusted to lead to new discoveries in the future. The remaining example which I have mentioned, the periodic law, was regarded by many chemists as a convenient means of arranging the facts of inorganic chemistry, but was expressly stated to be only empirical, since a theoretical basis was inconceivable. The work of Moseley, the discovery of the radioactive elements, and the conception of isotopes, have shown the periodic classification to be the most fundamental thing in the chemistry of the elements, and the atomic number has been found to have greater theoretical significance than the atomic weight. Reference to isotopes reminds us that this discovery also was made by chemical means, although its investigation appears almost to have passed out of the hands of the chemist into those of the physicist, since the introduction of the positive ray method of analysis. It was the chemical work of Soddy, Russell, Fleck and Fajans, establishing the fact that two or more elements, differing in atomic weight but identical in chemical properties, could occupy the same position in the periodic classification, which opened up this new and extraordinarily important and interesting field of research.

Two physical doctrines, originating outside of chemistry ,have had and are having a profound influence in the science—the ionic hypothesis and Bohr's hypothesis as to the internal structure of the atom. The former has had its opponents among chemists, although it has been generally accepted. One can understand the uneasy feeling of the chemist habituated to dealing with real things, when presented with formulæ which are only strictly valid for infinitely dilute solutions, and are apt to break down when the solution reaches the concentrations at which he is accustomed to work in the laboratory. The modern work on the hydration of ions has made it more possible to reconcile the theory with the facts, but at the expense of additional complications. Invaluable as the conception is to the physical chemist, therefore, I venture to think that it should be used sparingly in the elementary teaching of chemical reactions. I have in view more particularly the teaching of analytical chemistry. A text-book of that subject, written entirely in the language of ions, is apt to lead the student to believe that the truth of the statements he is reading is bound up with that of the hypothesis, and to obscure the fact that the analytical reactions were firmly established by experiment without reference to any hypothesis, whilst they are carried out in solutions so concentrated that a strict application of the formulæ is practically impossible. This view may be somewhat heretical, but I submit it for the serious consideration of teachers, particularly of those who have to train professional analysts, in whom skill and accuracy are all-important.

The development of the theory of atomic structure, due mainly to Bohr, has necessarily affected modern views of chemistry. The theory was devised to explain the phenomena of radiation, and later proved to accommodate itself in a wonderful manner to those of chemical union, making use for the purpose of Werner's doctrine of co-ordination ,another successful chemical theory which I have passed over in the foregoing sketch. In its new form it promises to do much to reduce to order the facts of inorganic chemistry, still so far behind the organic part of the science in the perfection of its logic. The static atom of Langmuir, now abandoned, played an important part in bridging over the gap between the planetary arrangement, chiefly suited to the explanation of spectra, and the present highly developed system. Whilst recognising the immense value of the new ideas, may I once more venture to utter a word of warning? The modern student, in these days of higher certificates and honour degrees, tends to specialise in his scientific

studies at a very early stage, and, if introduced in detail to the new conceptions while still engaged in learning the elementary facts of chemistry, is likely to suppose that the facts depend on the theory, instead of the opposite being true. In place of describing the facts determined by analysis, a student in such a position will first give an account of the electronic arrangement of the atoms in question, and then proceed to deduce the formation of a compound, the existence of which had been proved a century or so ago. The danger may seem to be exaggerated, but it is nevertheless real. I would submit that the facts should be known to the student before he applies to them this interpretation, which may prove so fascinating as to distract his attention from the experimental basis of the science.

When we look at the enormous mass of chemical research which is published each year, filling a greater and greater space on our bookshelves, we may ask ourselves whether any progress comparable with that which I have been describing is perceptible. It will probably be admitted that the work is proceeding, for the most part ,along well-worn paths, although sometimes with most striking results. The work on the structure of carbohydrates under Irvine on the organic side, and that of McBain and his collaborators on soaps in physical chemistry, may be mentioned as examples of the highest class of productive investigation now in progress. On the theoretical side, chemistry would seem to have been marking time, contenting itself with waiting for discoveries in physics, which might then be applied. Quite recently, however, we have seen new explanations of the reactions of organic compounds, based on the ideas of polarity and of residual affinity. As we are to have a full discussion of this subject before the close of the meeting, in which we shall have the advantage of hearing the originators of the several hypotheses intended to co-ordinate the facts of organic reactivity describe their reasoning in their own language, I need not do more than welcome this new sign of activity in chemical thought. The doctrines have still to be submitted to the supreme test. The main service of the older hypotheses of atoms, of structure, etc., to which I have referred was not the co-ordination of existing knowledge, valuable as that was, but the prediction of new facts. All of them have passed that test triumphantly. New facts have been predicted, and the concordance of observation with prediction has been extraordinary. Confidence in an hypothesis grows with every successful prediction, until the mass of evidence in its favour proves overwhelming. Will history repeat itself in this respect? It is to be hoped that it will do so. The interpretation of the reactions of the elements by means of the Bohr electronic groupings has been greatly assisted by the fact that those reactions were already known, and it has been possible to develop the hypothesis by successive adaptations as more facts were considered, but the supreme test, that of predicting some entirely new range of phenomena, has still to be applied, and chemists will look eagerly for its success in due course. The same thing may be said of the theories of organic reactivity. Are they capable of opening up a new field of phenomena which would otherwise have remained unknown? To this question also we shall await an answer.

An unfortunate consequence of excessive and premature specialisation in the study of chemistry is the ignorance of many advancer students concerning the work of the great chemists of the past. When attention is mainly concentrated on the latest developments of some restricted branch of the science, the sense of historical perspective is lost, and too much weight is given to what may be only a perfection of detail. Faraday and his contemporaries are far too little known to our young graduates in chemistry. Some teachers of the subject adopt the admirable plan of giving an historical and biographical colouring to their teaching, so ensuring that their students understand something of the debt which the science of to-day owes to its great leaders of the past. The interest now being taken in the history of science generally, and the appearance of useful little manuals of the history of chemistry in particular, are hopeful signs. Our universities still lack a synthetic view of science as a whole, and there is little appearance of the general adoption of a philosophy of science which would bring about unity, but, if I may venture to express an opinion on such a conversial point, it is that scientific study and research ,with its inevitable increasing subdivision, will become less satisfactory as a mental discipline unless connected by a broad synthetic survey of science as a whole. The older metaphysics having proved a broken reed, men of science here and there are building up a working philosophy of their own, and it is permissible

to hope that investigators and philosophers together may, in due course, succeed in the construction of a synthesis in which the several sciences will be placed in due relation to one another, so that the minute field in which each investigator has of necessity to work will appear to him, not as a completely isolated region, but as a part of the great whole, the general outlines of which will be comprehended by every scientific worker.

(*To be continued.*)

NOTICES OF BOOKS.

Report of the Rothamsted Experimental Station, 1923-4. Harpenden. Price 2s. 6d.

The Rothamsted Experimental Station, founded in 1843, has carried out investigational work to discover the principles underlying the facts of agriculture, and to apply such knowledge for the improvement of industry by showing the farmers the practical results to be obtained by following the improved methods.

The most fundamental part of agriculture is crop production, and this has received most attention. The data collected have brought out, for instance, the differences between the actions of farmyard manures and artificial fertilisers. It is found that rainfall has a pronounced influence too.

The fertiliser investigation recorded in the latest publication from Rothamsted includes information concerning the size and time of dressing; use of chloride and sulphates, basic slag; action of potash on potatoes; and green manuring.

From the summary of scientific papers published from the station, it is seen that all branches of the subject are dealt with. The work is classified into Crops and Plant Growth; Statistical Methods and Results; Meterology; The Soil; and Diseases.

Many papers deal with chemical investigations, but all branches of science are embraced in the work.

J. G. F. D.

CORRESPONDENCE.

NOTE ON THE ACTION OF IODINE ON PHOSPHORUS PENTASULPHIDE.

The Chemical Laboratory,
Highbury New Park, N.5.

Sir,—

In a recent note (*Chem. News*, 1925, CXXXI., 38), attempts to prepare a perbromide of phosphorus pentasulphide were described; similar experiments have since been carried out with iodine and phosphorus pentasulphide with equally fruitless results. Suspensions of finely ground phosphorus pentasulphide in chloroform were treated with iodine dissolved in the same solvent under varying conditions; in other cases, phosphorus pentasulphide was added to saturated solutions of iodine in chloroform and the mixture boiled, warmed or allowed to stand for some days, the products being either filtered or dried on porous tiles. In all cases the sulphide was recovered unchanged and identified in the usual manner.

I am,
Yours, etc,
R. F. Hunter,
M.Sc., D.I.C., A.R.C.S.

September 1, 1925.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

20,729.—Akt. Ges fur Anilin Fabrikation.—Manufacture of sulphocyano derivatives. August 18th.

20,580.—Bentley, W. H.—Manufacture of sulphur. August 17th.

21,070.—Drew, H. D. K.—Preparation of aromatic derivatives of tellurium. August 22nd.

20,809.—Grasselli Chemical Co.—Manufacture of sulphuric acid. August 19th.

Specifications Published this Week.

237,987.—Nobel's Explosives Co., Ltd., McDavid, J. W., and Williams, E.—Recovery and concentration of nitric acid.

238,007.—De Laval Chadburn Co., Ltd.—Separators for liquids or other substances of different density.

230,447.—Suida, Dr. H.—Process for the recovery of concentrated acetic acid from dilute acetic acid.

Abstract Published This Week.

236,379.—Olefine oxides.—Burdick, J. N., Clendenin, West Virginia, U.S.A.

In the production of olefine oxides by treating chlorhydrins with strong alkali,

use is made of chlorhydrin solutions of less than 40 per cent. concentration and the olefine oxides are removed as soon as formed. Preferably solutions containing less than 15 per cent. chlorhydrin are employed. According to the example, a ten per cent. solution of ethylene chlorhydrin is heated to boiling by a reflux condenser, and the resulting ethylene oxide condensed in a cooled receiver. Propylene chlorhydrin may be similarly treated to give propylene oxides. Other alkalis such as alkaline earth hydroxides may be employed, and the removal of the product may be effected under reduced pressure.

Messrs. Rayner and Co., will obtain printed copies of the Published Specifications only, and forward on post free for the price of 1/6 each.

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

THE MOON'S SURFACE.

By F. H. LORING.

Modern advances in science demand attention to matters that are quite outside the conventional range of related subjects. For example, investigations of atomic structure has led the student into astronomical phenomena; yet the atom is considered as properly belonging to the domain of chemistry. Even so remote a subject as the surface of the moon becomes in a sense linked with atomic physics.

The moon's surface has been the object of much study and some speculation. The cause of the few mountain ranges on the moon, or more particularly the cause of the formation of so many thousand craters affords a problem of considerable interest.

It would appear that the craters had been formed by the bombardment of the moon's surface by huge explosive shells, rather than that the formations had been due to the action of pent-up gases which, in escaping, had thrown up molten material.

In the case of volcanic eruptions, as seen on the earth, stream-formations of lava should be in great evidence on the moon, owing to the large size of the craters there present, whereas, few, if any such lava flows appear on the moon.

The volcanic theory of the mountains or particularly the craters of the moon, has given way to the meteoric-bombardment theory. It has been suggested that meteorites, in striking the moon without there being any appreciable atmosphere thereon, would, in consequence, strike her surface at great velocities (say, 12 to 44 miles per second), and the energy of impact would render the meteorites instantaneously gaseous. This means practically bomb explosions, as indicated analogously above.

H. E. Ives (*Astrophysical Journal*, 1919, Vol. 50, p. 245), has said: "The explanation readiest to hand—that the rings, pits and peaks are the result of volcanic action—does not appear to be adequate when closely studied. While superficially similar in appearance to terrestrial volcanoes, the lunar 'craters' exhibit significant differences of structure from these. The crater floors are lower than the surrounding country instead of higher, as they are in most terrestrial volcanoes, the central peak is often missing, and the amount of material piled up in the ring mountain is less than would be deposited there by volcanoes we know. It has, however, been pointed out by W. H. Pickering that the volcanoes of Hawaii are quite similar to the lunar configurations."

Ives, in his paper, has shown photographic reproductions of bombarded territory, produced by bombs having been dropped from aeroplanes in war experiments. Comparing the pits and their attendant rings, as photographed at high elevation from an aeroplane, with telescopic photographs of lunar areas, the resemblance is remarkably striking. In fact, so closely do some of the photographs of the bomb craters resemble some of the lunar craters, that it is difficult to distinguish between them. Photographic reproductions of the moon's surface are shown in so many books on astronomy it is unnecessary to introduce them here.

It will be noticed than on the moon there are overlapping craters which would be difficult to explain on the purely volcanic theory, whereas, from the bombardment theory, this overlapping would be expected.

Ives has pointed out (*loc. cit.*), that the velocity at impact would give rise to the meteorites being suddenly raised to a temperature amounting to thousands of degrees centigrade, sufficient to render them instantaneously gaseous. That is to say, an cannot be dogmatic), the velocity at would at least account for the circular formations, as the gases would expand in all

directions, more or less from a central point: the place of impact.

There is a small crater in Arizona, Canyon Diabolo, which resembles closely a lunar crater, and in this instance there is no evidence of volcanic action having taken place. The earth's atmosphere has evidently been a good cloak of protection against extensive pitting by meteoric bombardment at some early epoch. This seems true, because on examining the structure of rock formations, no indication of buried craters have been revealed, so far as the writer is aware.

The meteoric theory of the lunar craters has been objected to on the ground that there are too many *circular* craters, since with nearly grazing impacts which, from probability considerations, must have been numerous, there should be more signs of guttering or elongated ridges. There are, in fact, comparatively few very oval craters.

To meet this objection, if it be valid (one cannot be dogmatic), the velocity at meteoric impact, for reasons not difficult to imagine, may not have been so great as supposed, and the bodies might have been *explosive* in the ordinary sense of the term. This supplementary idea would make it unnecessary to assume very high velocities, so that the meteorites by virtue of gravitational attraction, would strike the body of the moon more frequently in a direction nearly at right-angles to her surface, and yet the disruptive violence would be sufficient owing to the bombarding material being explosive. This view is here mentioned, as it is in harmony with the theory that the asteroids resulted from a series of explosions in the material of an at-one-time *single* planet of appreciable size.

H. Jeffreys (" The Earth," 1924, p. 60), says, speaking of the formation of the asteroids (numbering over one or two thousand) " of their large eccentricities and inclination agree equally with the theories of explosion and tidal disruption. Some may have been captured; in particular, it is possible that the satellites of Mars are captured asteroids. Large variations in the eccentricities of the orbits would be set up by the perturbations due to the planets, especially Jupiter, and the positions of the nodes and the apses would be continually varying." Furthermore, Jeffreys says: "Explosion is possible, though there is little evidence for it. If the planet contained enough radioactive matter to heat part of its interior up to the boiling point, the disruptive stresses might come to exceed the small gravitative power of such a mass and permit explosion, and if one explosion took place, there is no reason why others should not follow, since gravity would diminish at every rupture. Tidal disruption by close approach to Jupiter is also possible; the small planet would have to approach very close to the surface of Jupiter, and might be repeatedly broken up during a single encounter." No mention is made of a *chemically-explosive* planet.

It must be remembered that the idea of the disintegrations or explosions, starting with a single planet, to account for the multiplicity of the asteroids, is not the only theory; for, according to the planetesimal hypothesis of Chamberlin and Moulton, " The fact that there over a thousand asteroids between the orbits of Mars and Jupiter merely tells us that there was no dominant nucleus in this region from the beginning; and the zodiacal light suggests that the process of aggregation is not yet fully completed "—to quote from W. D. McMillan (*Science*, July 24, 1925, particularly page 72. It may be noted that the harmonic mean between the distances of the extreme asteroids Eros and Achilles comes out 20.6, which is close to the theoretical " B " value 21 (see *Chemical News*, 1923, CXXVII., p. 290), but what this means it is impossible to say at present. The dividing constant for the planet distances in miles is in this case 10,317,000.

These matters are of interest from the geological and mining side, because the distribution of valuable metals and certain non-metallic elements, *e.g.*, diamonds, leads to inquiries as to their origin, which in turn leads to the consideration of physical phenomena of the kind here discussed with reference to the moon. For example, carbon monoxide has been found in meteorites, and the Canyon Diabolo meteorite is said to have contained black and transparent diamonds. Unusual minerals are of interest in this connection.

Before concluding this short survey, attention should be drawn to another feature of the moon's surface. One very remarkable fact is the observed radial streaks or rays, emanating from certain craters, which are of lighter colour than the general surface of the moon. While they appear to occur only in the case of a few craters—notably that of Tycho—where they are observed clearly, they extend great distances, hundreds of miles in some

instances. They are from 5 to 10 miles wide—or even wider in places—and they do not appear to be cracks in the moon's surface, as no shadows are seen; and, besides, they are lighter in colour, as just mentioned. They pass over and through craters, across the mountains, and for this reason it is difficult to imagine that cracks were originally formed which were filled practically flush with the adjoining surface by molten matter rising upwards from the moon's interior—due to hydrostatic pressure—and so filling them. Although magma forced upwards might have the lighter colour, it seems difficult to understand the absence of deep recesses at the highest places, unless the shrinkage of the moon's crust and the partial closing up of the cracks had forced the magma to the surface in these very high places.

Since the streaks are associated with craters (some craters show radial rays numbering, say 13, if one were to show them in diagram, but there are, in detail, more, and they blend together centrally as a splash of ink would do), and the craters appear to have been formed by exploding meteorites, it is just conceivable that the explosions in certain circumstances gave rise to long vapourous streaks or heavy dust-like clouds, which deposited their whitish matter when they settled down in sweeping over the rough lunar surface.

Another explanation mentioned in Young's "Manual of Astronomy," is that the streaks have been formed by vapours ascending from rifts or cracks too narrow to be telescopically visible.

Jeffreys has discussed the origin of these lunar streaks in the chapter on surface features in his book cited above.

The surface of the moon presents other interesting characteristics. It is well known, for example, that there are long valleys or rills; deep cracks or clefts, some fairly straight and extending in a few instances several hundred miles, and quite unique is the Valley of the Alps, a straight deep wide gash 83 miles long and about 6 miles wide (see Heath's "Popular Astronomy" (Atlas) 3rd edition, page 76); also large plains (*maria*). Many of the big craters are about 10 times the diameter of terrestrial craters, the former being about 50 miles, but exceptional craters over 100 miles in diameter are known. Those 5 to 20 miles across are very numerous, running into hundreds. There are also some depressions without elevated outer rings. There are, in short, a great many small depressions, holes, or craterlets. The heights of the mountains and peaks vary, the latter attaining to about 26,000 feet; this figure also representing nearly the total number of craters in the visible half of the moon. Taking the gravitational attraction at the surface of the earth as unity, it is only 0.16 on the moon ($= \frac{1}{6}$). The surface area of the moon as compared with that of the earth is in the proportion of 0.074 to 1.

In conclusion, a note of caution seems necessary, for some of the figures hereinabove given are only approximate, as will be realised when studying the photographic reproductions of the moon's very rough surface.

An article by the present writer on "Meteors," in the *Chemical News*, August 14 and 21, 1925, forms a companion to this one.

A MUCH IMPROVED THERMO-ELECTRIC GENERATOR.

In the *Daily News*, of September 4th, 1925, the following item appears :—

"What may be a remarkable development of electric power production is foreshadowed in a preliminary report issued from Sheffield University last night of experiments carried out by Dr. T. F. Wall, of the research staff.

The idea appears to be based on the theory of a German investigator before the war, who discovered a secret alloy and the junction when heated to 400 degrees centigrade developed great electro-motive force.

Dr. Wall states that he has obtained by a new special process a practical form of thermo-junction, capable of developing .05 volts at a given temperature. His proposal is to place such junctions together and make a thermo-electrical generator. One estimate places the cost of a thermo-electric generator at about half the price of a steam engine plant, and the cost of producing electricity at a third the present cost.

The new generator, it is claimed, will need no other attention to generate electricity than stoking the heating apparatus underneath it with coal.

No steam boilers, engines or moving machinery will be needed. It is thought that the German scientist was killed in the war."

Dr. Wall is the author of the well-known book "Electrical Engineering," published

by Messrs. Methuen. Some time ago, Dr. Wall announced that he was making experiments with the view of breaking up atoms by subjecting matter to very intense magnetic fields; for if the atoms contain electrons describing orbits, in sufficiently strong magnetic fields they should be sufficiently deflected as to disrupt the atom. No results however have yet appeared to show that such disruption is possible by this method, although exceedingly intense fields were tried.

Referring to the new or improved thermo-electric junction, it will be remembered that with a bismuth wire and an antimony wire joined together, the E.M.F. of 0.0001 volt for one degree is obtained, that is to say, when the difference of temperature between the elements of the junctions is maintained at one degree Centigrade, within certain temperature limits. It would appear that Dr. Wall has raised this value to 0.05 volt, a most remarkable result if this is the interpretation of the announcement. Dr. Will has filed provisional applications for patents for thermo-electric generation, which are numbered 18154, 18438, 18645, and 20135 (July and August). Further developments will be awaited with interest. F. H. L.

CHROMITE.

By EDWARD SAMPSON *and* H. M. MEYER. (U.S.A. Geological Survey.)

Chromite is among the few industrially essential minerals used in large quantity in the United States of which the supply is normally obtained in distant lands. Therefore, any disturbance of international trade relations greatly affects the industry. In 1922, for the first time in seven years, there was a promise of return to a stable condition, and in 1923 this promise was fulfilled.

Domestic deposits furnish only an insignificant part of the chromite used in this country, for there is no known deposit of massive chromite in the United States comparable in size to the great deposits in several foreign countries. The transportation costs to which domestic chromits is subjected are high, for the deposits distant from existing lines do not warrant the construction of special railroads, and the few deposits that are favourably situated with respect to railroad transportation are far removed from the chief markets. In addition to these difficulties, most of the domestic ore is of low grade. Of our annual consumption of about 100,000 tons, only a few hundred tons comes from domestic sources.

In 1923, 227 long tons of chromite were shipped from the mines, as compared with 855 tons in 1922. These figures are of the same order of magnitude as pre-war figures, and it seems improbable that there will be a substantial increase in the near future. The 227 tons of chromite shipped in 1923 averaged 47 per cent. of chromic oxide (Cr_2O_3), as compared with 49.7 per cent. in 1922. These figures compare favourably with the content of the imported grades. The shipments in 1923 were equivalent to 214 tons of 50 per cent ore. Besides this high-grade ore, 335 tons of 35 to 45 per cent. ore were mined but not shipped. The shipments were the smallest since 1912.

It appears that while Rhodesia is sending more chromite to the United States she is having to meet increased competition from India for European markets. Production in Rhodesia increased from 85,000 metric tons in 1922, to 88,000 tons in 1923. Probably the imports recorded as from British South Africa and Portuguese Africa cover the Rhodesian imports into the United States. The imports of chromite into the United States from British India in 1923 (29,238 long tons) were considerably larger than the total production for that country in 1922 (22,777 long tons). The increase in imports was due largely to the greatly increased activity in Mysore. In 1923 more than 14,000 tons of ore from the Mysore field were imported into the United States for use in refractories, whereas in 1922 almost the entire output of India came from Baluchistan. Imports from Greece increased from 8,600 long tons in 1922 to 10,550 tons in 1923. The prices of imported chromite in the U.S.A., range from 20 dollars to 25 dollars per ton.

SCIENCE COURSES AT PRAGUE.

We have received from the Charles University of Prague the Prospectus of Courses in research and other work for foreign students in the Faculty of Science.

Foreign students are eligible for experimental research work in Natural Science provided they have already completed a course equal to that of a Science Degree at a recognised University, or have had special training in the particular branch of science which they intend to study.

The degree of the Faculty is *Doctor Rerum Naturalium.* Candidates for the

degree must have completed at least four years' University work, any part of which may be taken at any University of standing. The requirements for the degree are (a) an approved thesis; and (b) two oral examinations. The examinations are usually conducted in the Czech language, but may be taken entirely (thesis as well) in either English, French, German or Russian.

Information is also given in the prospectus concerning athletic facilities.

So far as the chemical departments are concerned, the prospective student has a choice of several professors well-known to this country, under whom he may work.

Post graduate students can be confidently recommended to spend a year working in the well-equipped laboratories of this historic University. Intending students should write to the Dean of the Faculty of Science, Charles University, Prague, II.

QUOTATIONS FOR CHEMICALS FOR EGYPT.

Messrs. Yannopoulos-Cassaris, of Alexandria, require quotations from English makers of a wide range of chemicals to be sent c.i.f. Alexandria, and c.i.f. Jaffa.

The chemicals required include alkalis, acids, heavy organic chemicals, and such salts as sulphate of soda.

General Notes.

CHEMICAL INDUSTRY.

After a series of slight reductions the price of sulphate of ammonia has begun to rise, very largely owing to the depression in the coal and steel industries having restricted the output. On the other hand, the contemplated expansion of the plant for the production of the synthetic material may well be expected to give rise to an in crease in production.

From the Board of Trade returns, it appears that the exports of bleaching powder were nearly 50 per cent. greater during the first seven months of this year than during the corresponding period last year, and the position generally was hopeful. There was a decided decrease in the exports of benzol, but this is to be accounted for by the remarkable increase in the home demand. The materials in which there was an increase in the quantities imported were in general raw materials.

Among fine chemicals there has been considerable reduction in the price of salicylic acid owing to Continental competition, and at 1s. 2½d.—1h. 3½d., the British product is holding its own. British manufacturers of methyl salicylate, having reduced their prices, are able to sell at 1s. 4½d., against 1s. 9d., which is charged for the imported article. There has been strong Continental competition in benzol products, with a fall in price.

NEW STEELS AND THEIR PROPERTIES.

An interesting exhibit was prepared by Sir Robert Hadfield, Bart., F.R.S., for a recent Conversazione of the Royal Society. Micro-photographs and specimens of various steels were exhibited. Regarding manganese steel, the exhibits illustrated its property of deformation hardness, *i.e.*, the extraordinary increase in hardness in this steel which is caused by strain and accounts for its remarkable resistance to wear and also the difficulty met with in machining the substance. Specimens were shown of manganese and nickel steels, both magnetic and non magnetic.

Heat-resisting and non-scaling steels are of extreme importance in to-day's industrial development in the field of high temperature operations, especially in regard to valves and nozzles. These steels of iron, nickel, and chromium alloy resist scaling even at 1,000° C., in oxidising atmospheres; interesting specimens were on view. Non-corrodible steels which have been developed under Angle-French auspices were shown in conjunction with an exhibit which well illustrated the development of what may be regarded as anti-corrosive measures. First there was the protective coating, either metallic or paint; then came the pure iron; thirdly, what is known as copper steel—that is, a small proportion of copper added to mild steel—fourthly, the non-rusting chromium steel which marked a distinct step forward; and finally the special steels which do not depend upon heat treatment or special preparation of surfaces for their resisting powers. Micro photographs of one of these special steels were shown and also many applications of the same to ordinary trade purposes—for instance, turbine blades.

A further interesting section dealt with

silicon steel and X-ray spectograms of silicon steel and pure iron were exhibited. These show, as was first discovered by Professor K. Honda, that the crystalline structure of the two materials is indistinguishable and tends to prove that the remarkable magnetic properties of silicon steel are not due to any special crystalline formation, but that the magnetic properties reside in the individual atoms.

THE ASBESTOS INDUSTRY OF CANADA.

The effort to bring about a general merger of the asbestos-producing companies of Canada has not yet met with success, the terms not being satisfactory to the Asbestos Corporation of Canada, Limited. It had been hoped that by effecting a merger of the Canadian producers, conditions would be established that would eliminate keen competition among themselves and enable them better to meet the competition of foreign producers. There has been a marked decline in the average value of asbestos per ton during the last five years. Returns shew 225,744 tons of materials sold and shipped during 1924, valued at £1,378,937.

Exports of unmanufactured Canadian asbestos in 1924 amounted to 204,749 tons. The great proportion of the total output is consumed outside of Canada. This is an indication of the importance in Canadian affairs of any move that may be made towards holding the foreign markets.

THE INDUSTRIAL APPLICATIONS OF COAL TAR PRODUCTS.

Written for Messrs. Ernest Benn, by Messrs. Bunbury and Davidson, this work should be particularly useful at the present juncture to the heavy chemical industry. The aim of the work is to draw the attention of manufacturers, chemists, tar distillers, etc., to the full range of the materials which can be profitably isolated from coal tar, and to discuss their uses and potential uses in a thoroughly practical manner. Even to-day, the full possibilities of the coal tar products—crude, intermediate, and refined—are not too well known, and in this critical examination of them the authors have endeavoured to render a really practical service to the industry.

The Industrial Applications of Coal Tar Products was published on the 10th inst.

THE SIR JOHN CASS TECHNICAL INSTITUTE.

JEWRY STREET, ALDGATE, LONDON, E.C.3.

The Session 1925-26 will commence on Monday, September 21st.

Students will be enrolled on Wednesday, Thursday and Friday, September 16, 17, and 18, from 6 to 8.30 p.m.

Instruction is given in the following subjects:—Pure and Applied Mathematics, Physics, Chemistry, Fermentation Industries, Petroleum Technology, Gas Manufacture, Metallurgy, Arts and Crafts, Modern Languages and Trade Classes.

The courses of instruction are held from 6 to 10 p.m., and meet the requirements of those engaged in chemical, metallurgical, electrical, petroleum and the fermentation industries and in artistic crafts and the tailoring trade.

The following courses will be included in the syllabus:—Differential equations and vector analysis; colloids; alternating currents and electrical oscillations; electrolytic analysis; anthracene and its derivatives; technical gas analysis; gas manufacture; brewing and malting; bottling and cellar management; micro-biology petroleum technology; metallography, pyrometry and heat treatment of metals and alloys; mechanical testing of metals and alloys; fuel refractories and furnaces; electro-metallurgy; dental metallurgy; mineralogy; foundry practice and metals relating thereto; mining and surveying; applications of engineering.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENCES IN AUGUST 1925.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during August, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 392, of which 281 were from merchants or importers. To these should be added 17 cases outstanding on the 31st July, making a total for the month of 409. These were dealt with as follows:—

Granted—276 (of which 254 were dealt with within 7 days of receipt).

Referred to British makers of similar pro-

ducts—82 (of which 61 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—27 (all dealt with within 2 days of receipt).

Outstanding on 31 August, 1925—24..

Of the total of 405 applications received, 342, or 84 per cent., were dealt with within 7 days of receipt.

GENERAL COUNCIL OF MEDICAL EDUCATION AND REGISTRATION OF THE UNITED KINGDOM.

Powers, Duties, and Constitution of the General Medical Council.

The powers and duties of the General Medical Council, or "General Council of Medical Education and Registration of the United Kingdom" to give the Council its full title, have been set out in detail in many previous Students' Numbers of *The Lancet*. It is first a registering body; no person, even though his qualifications have been obtained by examination, is a legally qualified medical practitioner until his name appears on the Medical Register. Secondly, it is a standardising body, ensuring that medical education reaches an efficient standard by scientific examination. Thirdly, it is a penal and disciplinary body, having power to remove from the Register any practitioner adjudged guilty of conduct "infamous in a professional respect." Fourthly, to the Council is committed the codification of pharmaceutical remedies. The duties of the Council are thus primarily of a public nature, and its construction shows its fitness for its fourfold responsibilities.

The Council at present consists of 38 members, or whom all but 11 are official representatives of some corporate body. Five members are chosen by the Crown on the advice of the Privy Council, and six others are elected by the members of the medical profession as Direct Representatives. There are also three additional members appointed by the Privy Council under the Dentists Act, 1921, under which the powers and duties of the General Medical Council with regard to the keeping of the Dentists' Register and the administration of the Dentists Acts were largely transferred to the Dental Board of the United Kingdom.

The President of the General Council is Sir Donald MacAlister, and the sitting members of the Council are enumerated in the Medical Register. —*The Lancet.*

THE LANCET.

The issue for August 29th was the Students' Number, Session 1925-1926.

It contains salient particulars of the various medical colleges, hospitals, etc., in Great Britain and Ireland, and also the Army and olonial Medical Service. The issue cannot fail to prove valuable as a work of reference, not only to medical students and medical men in particular, but in a more general sense to all interested in medical and health subjects.

The Students' Guide (particulars of dental surgery) was continued in the issue for September 5.

RELATIVITY.

Science of July 31st, 1925, under the title "The Relativity Theory and the Ether Drift," records that Einstein has said:— "If Dr. Miller's results should be confirmed, then the special relativity theory in its present form, fails."

The fullest account of Dr. Miller's experiments, thus far published, is given by himself in the June number of the *Proceedings of the National Academy of Sciences of U.S.A.*

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section B.—Chemistry.

THE CHEMISTRY OF SOLIDS.

Address by Professor Cecil H. Desch, D.Sc., Ph.D., F.R.S., President of the Section.

(*Continued From Last Week.*)

I trust that these criticisms will not be thought impertinent in one whose work lies in a specialised branch of applied chemistry, that of the common metals and their alloys, and I may now pass to the proper subject of this address, the chemistry of the solid state. It is remarkable how little we know with any certainty about the chemical properties of solids, although the idea of a solid is so fundamental. At the present time we always begin the study of chemistry with the gases on account of the simplicity of their mathematical treatment, but it must be remembered that this simplicity is the result of long study and of many discoveries. To the unscientific mind the solid is simpler, because more tangible. When men have tried to under-

stand gases, they have expressed themselves in terms of solids. The atom, however attenuated it may have become in recent years, was in the first instance essentially a solid sphere, and the elasticity of gases has been explained in terms of the collision of elastic solid particles in motion. Newton described the atoms as 'solid, hard, impenetrable, movable particles . . . incomparably harder than any porous body compounded of them, even so very hard as never to wear or break in pieces,' and this conception has been found useful in the course of the history of atomic and molecular theories, more so than the alternative view, associated with the name of Boscovitch, which regarded the atoms as mathematical points or centres of force, a highly abstract idea, and one having no analogy in common experience. Our conception of liquids has been based in the same way on the idea of moving particles, themselves thought of in terms of the solid state. And yet, of solids themselves, whilst our knowledge of their physical and mechanical properties is very extensive, our chemical information is of the most meagre kind. It is an old doctrine that chemical reactions could only proceed in the gaseous or liquid states, so that chemical action on a solid was always preceded by the tearing off of atoms from the surface under the influence of electrical forces. That view can no longer be maintained. Chemical reactions can occur within or at the surface of a solid, but the experimental difficulties are sometimes such as to make the exact investigation of the subject a difficult matter.

In the modern conception of a solid, the atoms are characterised by a regular arrangement in space, that arrangement being repeated so as to build up a crystalline lattice. Crystals and aggregates of crystals are thus the only true solids, glasses being regarded as under-cooled liquids of high viscosity. Since the early beginnings of the geometry of crystals due to Haüy, the study of their geometrical form has reached a remarkable state of perfection, all the possible lattices have been determined, and there is perfect agreement among crystallographers as to the classification of forms and the optical properties of different types of crystals. The X-ray method developed by Laue and by W. H. and W. L. Bragg has carried the matter an important stage further, by making it possible to determine, not only the class of a crystal, but the exact lattice possible to crystals belonging to that class. The connection between the chemical properties and the crystalline structure still remains indeterminate, although it must be very intimate. I shall revert to this point later.

There are many reasons why the chemical study of solids should receive greater attention. In metallurgy, although metals and alloys may, and most frequently do, pass through a molten stage in the course of their manufacture, they may undergo many important changes of structure and constitution at temperatures far below that at which the last liquid portions have completely solidified, and these changes may be so far-reaching as to convert an alloy into one seemingly of an entirely different class, although the gross chemical composition has not altered. The petrologist, especially when dealing with igneous and metamorphic rocks, has to consider reactions which proceed in the midst of solids of high rigidity. Several industries, such as that of cement, are based on reactions of the same kind as those with which the petrologist has to deal. Sintering is not always due to the presence of small quantities of molten material between the solid particles, and it is now certain that union of solid masses under pressure may occur without actual melting. This was shown by Spring forty years ago, but for long, although frequently quoted, his results received little consideration. The most striking application of the principle is seen in the metallurgy of tungsten. This metal was formerly described as very hard and brittle, and it is not possible, by casting it and then annealing, to bring it to a ductile form. The method now adopted is to prepare it in the form of a pure powder, and then to bring it to a compact state by compressing, heating, and hammering while very hot, and finally drawing. As this process is continued, and as an originally thick rod becomes extended into a slender wire, the brittleness progressively disappears, and at last the tungsten is obtained in those beautiful filaments drawn to extreme fineness, with which we are familiar in our electric light bulbs and wireless valves. Even several of the common metals, when their powders are compresses under suitable conditions of temperatures far below their melting points, are capable of forming compact masses with a mechanical strength of the same order as that of the cast metal. The conditions of these reactions, which have been studied by Sauerwald, suggest inter-

esting questions for consideration. A somewhat similar, but perhaps more difficult, problem is that of the adhesion of an electrolytically deposited metal to its support, which is sometimes so perfect as to approach the breaking strength of one of the metals although interpenetration of crystals is not to be seen under the microscope.

There is another aspect of the chemistry of solids which will make an appeal to some who are not chemists, but amateur students of Nature. The great beauty of natural crystals has attracted the attention of poets and artists as well as men of science. Much of this beauty depends on the varying habit of one and the same crystal species. Even with such a common mineral as quartz, it is possible on entering a mineral collection to point to some of the crystals exposed, and to name their locality, when once the form has become familiar. The same is true of other minerals. Why should there be this variation, when the chemical composition of the distinct varieties may be identical, so far as analysis is able to give information? Again, the crystalline system will not account for the differences in the building up of individuals to form aggregates. Rock salt and cuprite crystallise in cubes, and the space lattice has a very similar form in the two minerals, but when the salt forms multiple growths, the cubes arrange themselves in characteristic stepped pyramids, whilst the red oxide of copper may form the most beautiful hair-like threads, a tissue of scarlet silk, as Ruskin calls it. Neither mineral ever assumes a form which is characteristic of the other, the simple cube being once departed from. Why should this be? It is known that the presence of traces of foreign matter may cause differences of habit, the most famous instance being that of the crystallisation of common salt in octahedra instead of cubes when a small quantity of urea is added to the solution, but the explanation of these facts is still imperfect.

An important paper on this subject was published in the *Annales des Mines* as far back as 1818, by F. S. Beudant, who examined a large number of minerals and salts with the object of discovering the causes of variations of habit, concluding that the most important factor was the presence of foreign substances. This paper probably contains a larger mass of data than any later publication on the subject. Among recent workers, Gaubert has made an interesting study of the influence of impurities, especially of colouring matters, on habit. It was a problem which fascinated Ruskin, whose intimate knowledge of the forms of minerals, and keen desire to understand the reasons for their varying beauty, combined with a penetrating insight into natural phenomena, might have led him to discoveries of importance had he received greater help from his scientific friends. As it was, his chief contribution to the subject was his series of studies on agates and other banded formations, in which he anticipated some of the conclusions lately reached by Liesegang by entirely different methods, showing that the bands were produced by segregation from a gelatinous mass, and not, as had been supposed, and maintained until a few years ago, but the successive infiltration of fresh quantities of solution into a cavity.

According to Curie, the appearance of a given face on a growing crystal depends on the ratio of its surface energy to that of other possible faces, but it has been found that such differences of surface energy as occur are much too small to account for the effect. The work of Johnsen and of Gross has shown that the appearance of a face on a crystal placed in a supersaturated solution is really determined by the velocity of growth in a direction normal to that face. those faces being produced which have a minimum velocity of growth. The presence of impurities undoubtedly has an influence on the velocity, although the effect of very small quantities of impurity has been little studied. Some light is thrown on the subject by a study of the growth of a crystal when solvent is completely excluded, the substance used being sublimed in a vacuum. This has been undertaken by Volmer, who finds that cadmium, zinc and mercury crystals grow in this way in a high vacuum. When small nuclei are present, those grow which have the face with the smallest velocity of growth perpendicular to the stream of impinging molecules. The differences between different faces are large, so that under these conditions either flat tables or long prisms are usually formed, according to the direction of the original nucleus. The crystal grows by the addition of thin laminæ, probably only one molecule thick, which spread over the surface. This is likely to be the process when the crystal is growing in a solution or in a molten mass, as well as in the vapour; and, in fact, when cadmium or tin is being deposited electrolytically at a

cathode, or when lead iodide is being formed from a solution of a lead salt and an iodide, the growth of the crystal may be watched under the microscope, when a thin film begins to form at some point on a face, and extends over the face, maintaining a uniform thickness throughout. Marcellin had previously observed the same thing in *p*-toluidine, the layers not being more than two molecules thick, and probably only one. Marcellin also found that mica might be cleaved by Wood's method of pressure against fused selenium, until the laminæ had a thickness of one molecule. Moreover, there are indications that when molecules strike the surface of such a fresh crystal they first attach themselves irregularly in what is now called an adsorbed layer, before the film takes up regular orientation. It is realised that in the presence of a foreign substance either molecules or ions may attach themselves to such a surface by their residual affinity ,and this will necessarily affect the addition of ufrther layers of the original substance. In other words, the velocity of crystallisation in a direction normal to that face will be changed. As the residual affinity of different faces of a crystal must, from the ordinary conception of an atomic space lattice, be different, the habit of the crystal, that is the relative development of different faces, will be altered by the presence of a foreign substance. There is, in fact, evidence that dyes are not equally adsorbed by different faces of the same crystal, so that the state of things just imagined must exist. It is on these lines that an explanation of differences of habit must be sought.

(To be continued).

BRITISH ASSOCIATION OF SCIENCE 1925 (SOUTHAMPTON) TRANSACTIONS.

Abstracts of Papers.

Prof. L. S. Ornstein.—*Light Quantum Theory of Dispersion.*

If we want to discuss the equilibrium of electrons and radiation from the point of view of light quantum hypothesis, it is necessary to put the probability of collision of an electron and a light quantum proportional to the square of its ' wave length.' This result leads us to the hypothesis that a light quantum is a spherical volume of electro-magnetic energy with dimensions of the order of wave length. This hypothesis may be used in order in find the refractive order. If a light quantum strikes over an atom a force will be exercised on the quantum which is proportional to the volume of the atom and to the gradient of the field in the quantum. The order of magnitude of this gradient may be estimated from the hypothesis mentioned. During the interaction the momentum of the quantum is put proportional to $\frac{hc}{\lambda v}$ (h Planck constant, c velocity of light in ether, v velocity in the quantum and λ wave length). From the above the retardation of a quantum by an atom can be calculated; and taking into account the probability of collision with the atoms the ordinary formula for the refractive index for long waves can be found.

In the light quantum theory, dispersion can be obtained by taking into account—just as in the old theory—the inertia of the electric masses in the atom. The influence of damping by radiation, which plays a part in the old theory, also finds its counterpart in our light quantum considerations.

Abstract.

Sir Napier Shaw.—*Trigger Action in the Atmosphere.*

In discussions of the transformations of energy in the atmosphere it is sometimes suggested in explanation of certain kinds of rainfall that there may be something in the atmosphere analogous to catalytic action by which the transformation is initiated and continued, although the energy which is transformed is not supplied by the initiating agent, but is derived from the interaction of the constituent parts of the rest of the atmosphere. One of the characteristic features of such a condition is the discontinuity between two states which differ only in the presence or absence of the ' catalyser ' or initiating agent.

A certain line of real discontinuity in atmospheric conditions is marked by the saturation of the air with water-vapour, the behaviour under the gradual reduction of pressure being fundamentally different when the air is saturated from what it is when unsaturated. Thus the consideration of saturated air in the atmosphere requires the introduction of ideas more or less suggestive of ' trigger action,' and the purpose of this communication is to trace the effect of saturating air with water- vapour as an example of ' trigger action.'

Assuming that the condensation of water-vapour to form rain is a consequence of the reduction of pressure, we recognise at the outset that the transformation of energy associated with rain is two-fold in character. There is first the gravitational energy of the environment which forces some portion of the air to rise, and secondly there is the development, in the form of sensible heat during elevation, of what was originally latent in the vapour. The energy of the second kind operates to limit the reduction of temperature, by reduced pressure, to an amount much below that which would be consequent upon the same reduction of pressure if the air were dry, and thereby to maintain or even increase the amount of energy available in the environment for further automatic eleavtion.

The development of ancillary energy in the environment in this way may be so great as to place the originally saturated air in a condition which, without unfairness, may be described as explosive; and it is on that account that the name 'trigger action' may be applied to it.

But although in this way saturated air may be regarded as a trigger which when properly operative sets the whole transformation in motion or even in commotion, yet the ancillary energy comes from the saturated air available. In a sense therefore, the trigger has to expend itself in producing the explosion, and the process is on that account not exactly catalytic.

The communication draws attention to the parts which are taken, by the environment and the environed air respectively, in this explosive action, and illustrates the subject by examples derived from the exploration of the pressure, temperature and humidity of the air by sounding balloons, kites or aeroplanes. For this purpose the results of soundings are set out in certain new diagrams, which, for the sake of reference, are called 'tephigrams,' and 'depegrams.' A tephigram, like an indicator diagram, shows the properties of the environing air in a vertical section of the atmosphere referred to (t) temperature and (ϕ) entropy as co-ordinates, with a background exhibiting the physical properties of saturated air, and a depegram shows the properties of the air in the same vertical section referred to the temperature of its dewpoint (d) and its pressure (p).

MR. J. H. SHAXBY.—*The Diffusion of Suspended Particles and Avogadro's Number.*

As a suspension settles under gravity a certain number of its particles reach the vertical walls of the containing vessel as a result of the Brownian movements; they can be made to adhere to it and can thus be counted. Their number increases with depth, since the time during which a given level of the wall is in contact with fluid containing particles is limited by the rate of fall of the upper boundary of the settling cloud. The adherent population thus gives a measure of the diffusion and provides its own time-record if the rate of settling is known. From the theory of diffusion, due to Smoluchowski, Avogadro's Number can be determined. In the present work the particles used were the minute natural spheres of Staphylococcus. Avogadro's Number was found to be 5.9×10^{23}.

PROF. H. BATEMAN, F.R.S.—*A Certain System of Partial Differential Equations.*

If λ and μ are constants the equations

$$\lambda\frac{\delta m}{\delta y} = \frac{\delta p}{\delta z} - \frac{\delta r}{\delta x}, \qquad \lambda\frac{\delta l}{\delta x} = \frac{\delta r}{\delta y} - \frac{\delta q}{\delta z},$$

$$\lambda\frac{\delta n}{\delta z} = \frac{\delta q}{\delta x} - \frac{\delta p}{\delta y}, \qquad \mu\frac{\delta p}{x} = \frac{\delta n}{\delta y} - \frac{\delta m}{\delta z}$$

$$\mu\frac{\delta q}{\delta y} = \frac{\delta l}{\delta z} - \frac{\delta n}{\delta x} \qquad \mu\frac{\delta r}{\delta z} = \frac{\delta m}{\delta x} - \frac{\delta l}{\delta y}$$

imply that each of the six quantities, l, m, n, p, q, r, is a solution of the partial differential equation

$$\frac{\delta^3 V}{\delta x^3} + \frac{\delta^3 V}{\delta y^3} + \frac{\delta^3 V}{\delta z^3} + \lambda\mu\frac{\delta^3 V}{\delta x\delta y\delta z}$$

A set of solutions may be expressed by means of definite integrals of a well-known type.

MR. N. K. JOHNSON.—*A Study of the Vertical Gradient of Temperature in the Atmosphere near the Ground.*

The paper contains a preliminary discussion of the results obtained from an apparatus which gives autographic records of the vertical temperature gradient over the height intervals 1.2 m. to 7.1 m. and 1.2 m. to 17.1 m. above the ground. The description of the apparatus shows that the temperatures are measured by means of platinum resistance thermometers mounted

in special housings and kept continuously aspirated. The autographic records are made on a 'thread recorded' which utilises the out-of-balance current of a Wheatstone bridge network. The records for the years 1923-4 are discussed. Mean hourly values for each month are shown in a series of curves. In winter at midday the mean lapse between 1 m. and 17 m. is 0.7° F. (*i.e.*, 2½ times adiabatic), whilst in summer it is about 2.5° F. (*i.e.*, 8½ times adiabatic). Throughout the night of both winter and summer there is a mean inversion of about 1.3° F. between the same limits of height. In contrast with these mean values the extreme values recorded during each month are given. Between the heights of 1 m. and 17 m. lapses of 5.8° F. (20 times adiabatic) have been found and inversions as large as 120° F. Tables are also given showing the frequency of occurrence of gradients of various magnitudes.

A number of selected charts are reproduced, and a detailed discussion is given of the various features which they contain, and of the factors which determine the magnitude of the temperature gradient in this region of the atmosphere.

(*To be Continued.*)

THE FARADAY SOCIETY.

GENERAL DISCUSSION ON "PHOTOCHEMICAL REACTIONS IN LIQUIDS AND GASES."

To be held in the Lecture Rooms of the Sir Leoline Jenkyn Laboratory, Jesus College, Oxford, on October 1, and 2, 1925.

Programme of Papers.

THURSDAY, OCTOBER 1, 3.30-5; 5.30-7.30.
Chairman: Professor F. G. Donnan, President.

PART I.—EINSTEIN'S LAW OF PHOTOCHEMICAL EQUIVALENCE.

PROF. A. J. ALLMAND (London University): Introductory paper.

PROF. F. WEIGERT and DR. L. BRODMAN Baly (Liverpool); Dr. J. A. Christiansen *Photochemical Equivalent law in a very Simple Photo-sensitive Liquid System.*

PROF. CHR. WINTHER (Copenhagen): *The Relation between Quantum Sensitivity and Intensity of Radiation.*

PROF. J. RICE (Liverpool): *Note on the Radiation Theory of Chemical Reactions.*

PROF. L. S. ORNSTEIN (Utrecht): *Note on the Innuence of Radiation on Chemical Reactions.*

PROF. D. BERTHELOT (Paris): *The Law of Photochemical Equivalents and the Place of the Quantum Theory in Relation to Atomic Theory and Energetics.*

PROF. P. LASAREFF (Hamburg): *On the Transformation of Atoms in Radiation.*

General Discussion.

FRIDAY, OCTOBER 2, 10-1; 2.30-5.

PART II.—ON THE MECHANISM OF PHOTOCHEMICAL REACTIONS

PROF. M. BODENSTEIN (Berlin): Introductory Paper.

PROF. J. FRANCK (Gottingen): *Elementary Processes of Photochemical Reactions in Gases.*

D. L. CHAPMAN (Oxford): *Some Conclusions from Recent Work on Photochemistry.*

PROF H. S. TAYLOR (Princeton): *Photosensitisation and the Mechanism of Chemical Reactions.*

E. J. BOWEN (Oxford): *The Dissociation Theory and Photochemical Thresholds.*

PROF. CHR. WINTHER (Copenhagen): *Dielectric Constant and the Speed of Photochemical Reactions.*

R. O. GRIFFITH and A. MCKEOWN (Liverpool): *The Photochemical and Thermal Decomposition of Ozone.*

DR. E. B. LUDLAM and W. WEST (Edinburgh): *The Electron Affinity of the Halogens.*

W. TAYLOR (Newcastle-on-Tyne): *The Physical Antecedents of the Photo-Activity of Chlorine.*

PROF. W. ALBERT NOYES, JR. (Chicago): *The Formation of Polar Compounds by Photochemical Reactions.*

PROF. VON HALBAN (Frankfurt a/M): *Absorption of Light in Solutions of Electrolytes.*

DR. H. KAUTSKY (Berlin): *On Chemiluminescence.*

General Discussion.

In addition to the authors of papers presented, the following are expected to take part in the discussions: Prof. E. C. C. Baly (Lievrpool; Dr. J. A. Christiansen (Copenhagen); Prof. P. Ehrenfest (Leyden); H. B. Hartley (Oxford); Prof. W. C. Lewis (Liverpool); Prof. F. A. Lindemann (Oxford); Prof. R. Luther (Dresden); Dr. E. K. Rideal (Cambridge);

Prof. O. W. Richardson (London); Dr. N. V. Sidgwick (Oxford).

Papers to be Communicated.

PROF. C. BERTHOUD (Neuchatel): *Photochemical Sensitization.*

MISS C. E. BLUKER (communicated by Prof. L. S. Ornstein): *Flame Spectra and Chemical Reaction.*

W. J. VAN DIJCK (communicated by Prof. L. S. Ornstein): *The Becquerel Effect on Copper Oxide Electrodes.*

PROF. J. PERRIN (Paris): *The Photochemistry of Flourescent Solutions.*

PROF. E. BAUER (Zurich): *The Photolysis of Methylene Blue Sensitized by Zinc Oxide.*

PROF. A. COHEN (Gottingen): *The Influence of Moisture on Photochemical Reactions in Gases.*

PROF. I. PLOTNIKOW (Zagreb):

(1) *Concerning the Fundamental Laws of Photochemistry;*

(2) *Photochemical Reactions and Methods of Measuring Them.*

PROF. N. R. DHAR and B. K. MUKERJI (Allahabad):

(1) *Einstein's Law of Photochemical Equivalence.*

(2) *The Mechanism of Photochemical Reactions.*

NOTICES OF BOOKS.

The Extra Pharmacopœa. Vol. II. 18th Edition. XLII. + 728 pp. Foolscap 8vo. By W. H. MARTINDALE, Ph. D., and W. W. WESTCOTT, M.B. Price 20s. net. H. K. Lewis and Co., Ltd., 136, Gower Street, London, W.C.1.

The popularity of this work is shewn by the fact that the present is the 18th edition. We notice that the use in the present volume of certain portions of the text of the U.S.A. Pharmacopœa is by virtue of permission received from the Board of Trustees of the U.S.A. Pharmacopœa Convention. It is stated that the "Board of Customs and Excise will be prepared to regard articles made in accordance with formulæ in the Extra Pharmacopœa as 'known, admitted and approved of' remedies for the purposes of medicine stamp duty, provided that a sufficient reference to the book appears in the labels under which the articles are sold."

SAMPLE ABSTRACTS.

Milk Analysis.

Average chemical composition of milk of good quality:—

Water	87.75
Fat	3.50
Casein	3.20*
Sugar	4.40*
Albumin	0.40*
Ash	0.75*
Solids—not fat	8.75

Milk also contains small quantities of citrates and enzymes.

Butter Analysis.

Average chemical composition of unadulterated butters:—

Water, 6.5 to 11.2%; curd, 2.4 to 3.1%; salt, 1.6 to 2.0%; fat, 83.7 to 89.5%.

Appendicitis.

Common intestinal parasites seem to be associated with this disease, *e.g.*, ascaris lumbricordes and tricocephabis dispar. Chauvel has pointed out that appendicitis appears to be the most prevalent among meat eaters, notably beaf-eaters. It is, on the other hand, unknown among the Arabs and Chinese. In religious communities in Brittany, where meat is never eaten, appendicitis is unknown. Disease of the vermiform appendix may be inhaled more frequently than commonly supposed by entozoa, *e.g.*, oxyuris vermicularis and tricocephalus trichiurus may prepare the way for bacterial infection.

A Manual of Chemistry for Medical Students, by ARTHUR P. LUFF, M.D., B.Sc., F.R.C.P. (Lond.), and HUGH C. H. CANDY, B.A., B.Sc. (Lond.) Vol. I., Seventh Edition, Introduction and Inorganic Chemistry. Pp. 578. Foolscap 8vo. Price 11s. net. Cassel and Company, Ltd., La Belle Sauvage, London, E.C.4.

This manual has been not only thoroughly revised in every paragraph, but enlarged. The enlargement was rendered necessary by the additions required in order to keep pace with the alterations in the examination syllabuses, but still more by the remarkable progress that has been made in the theory of chemistry during the past few years. As Mr. Candy remarks in the Preface to the new edition, "the conception of the atom associated with the name of Sir Ernest Rutherford, the identification of isotopes by Prof. Soddy, Dr. Aston, and others, and the revelation of crystal structure by the X-ray analyses of

Sir W. H. Bragg and others, have initiated an advance so rapid to a prospect so sublime, that imagination is almost breathless." These new conceptions and discoveries Mr. Candy had expounded in the introduction to the work with a lucidity and conciseness only possible to a master of the subject.

For the convenience of the student the work has been divided into two volumes, representing approximately the two-year or two-session course of the medical student. But each volume has a section on practical chemistry, and an index, and is therefore self-contained.

Specimen Page.

EXERCISES IN THE ESTIMATION OF CHLORINE PRESENT AS CHLORIDE.

1. *Standardizing the bench solution of silver nitrate.*—Weigh accurately about 1.5 grm. of pure NaCl; transfer the salt to a 500-c.c. flask, dissolve, and make up to the mark. Charge the burette with the bench solution of $AgNO_3$; place 100 c.c. of the salt solution in a beaker on white paper, or in a white dish, and titrate as in 1 (p. 550). Record the result in terms of $\frac{N}{1}$ $AgNo_3$.

2. *Estimation of ammonium chloride in the bench solution.*—Dilute 10 cc. of the bench solution of AmCl to 500 c.c., and titrate this diluted solution by method (1) (p. 552), using the solution of $AgNO_3$ as standardized in the previous exercise. State your result in grm. of NH_4Cl per litre, and compare it with that obtained for the same solution by another method in Exercise 7 (p. 514).

3. *Estimation of Cl present as chlorides in the tap-water.*—Place 100 c.c. of the tap-water in a beaker over white paper, and titrate as above. State result in gram. of Cl per 100 litres.

4. *Standardizing a solution of ammonium thiocyanate.*—In a clean winchester place 1 litre of distilled water; add to this between 7 and 8 grm. of AmSCy, dropping the crystals through a funnel, and then add 1 litre of distilled water; shake well till complete solution has taken place. Charge the burette with the solution. Place 10 c.c. of the standard $AgNO_3$ in a white dish, or in a beaker over white paper, add a little dilute HNO_3, and titrate with AmSCy as in (ii) (p. 553). Note the relation between the two solutions, and hence find the strength of the AmSCy. State it in terms of $\frac{N}{1}$ AmSCy. Use the two solutions in estimating the chlorine present as chloride in a sample of urine (5 c.c. diluted to 40) acidulated with HNO_3 (dil.).

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co, Regd Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

21,315.—Buttner Werke Akt. Ges.—Treatment of natural aluminium hydroxides. August 25th.

21,502.—Dodd, H. — Manufacture of hydroxychloranthraquinone. August 27th.

21,687.—Newbery, G.—Manufacture of acyl derivatives of amino aryl compounds. August 29th.

Specifications Published this Week.

215,790.—Metal Traders Technical, Ltd.—Process of concentrating sulphuric acid.

288,314.—Howards and Sons, Ltd., and Blagden, J. W.—Making synthetic menthol.

219,304.—Soc. of Chemical Industry in Basle.—Manufacture of acylated diamines.

238,385.—Sutherst, W. F., and Phillip, H.—Manufacture of finely divided sulphur.

Abstract Published this Week.

236,263.—Purifying oils and other liquids.—Remfry, F. G. P., and Dunstan, A. E., Meadhurst, Cadbury Road, Sunbury-on-Thames.

A mineral absorbent, such as baxuite, for filtering oils or other liquids is selected by taking the amount of heat given off when a quantity of the substance, immediately after roasting or ignition and without exposure to the atmosphere, is moistened with the liquid to be purified as an index of the efficiency of the substance for purification of that particular liquid. For the experiment a graduated cup may be used, a thermometer being placed with its bulb at or near the bottom. The method

may be used for selecting the best variety of bauxite for treating any particular oil as well as for ascertaining the most suitable maximum temperature for ignition or roasting and the most suitable degree of fineness, when any particular variety is selected.

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

DECOMPOSITION OF TRINITROTOLUENE BY THE ACTION OF SUNLIGHT.

By Professors C. Krauz and O. Turek.

Till the world-war, trinitrotoluene, *i.e.*, 2, 4, 6-trinitrotoluene was generally considered as a material of an almost unlimited resistance to shock and friction which "can be pressed, cut, bored, planed, etc." Its manufacture had not, up to that time, presented any obstacles, and the reason of the explosions which occurred here and there were not attributed to trinitrotoluene alone. Consequently, TNT (mainly in warfare), has been generally favoured, so that, where possible, it has been employed instead of picric acid.

The great faith in the perfect stability of TNT as far as sentitiveness is concerned was shaken, however, during the war. Already in 1915 the gun-barrel burstings were caused by shells filled with TNT, most of which could only be explained as the "self-explosion" of the TNT. Such accidents often happened during the filling of shells and hand-grenades with pressed or molten TNT, (*e.g.*, in Bolevec, 1917). Further, TNT can explode without any apparent reason during manufacture, as was the case in the unexpected explosion in the factory of the Nobel Dynamite Company at Bratislava, in 1918, when a whole TNT department was literally blown up.

Such unpleasant accidents were usually attributed to the impurities which might be found in technical TNT. That this view was, perhaps, in many cases correct, can be admitted. In such a speedy and sometimes, at least, accelerated production as occurred in the last war—when besides other obstacles, there were difficulties not only with the quality but also with the supply of raw materials—the product was not always the cleanest. Further, substances are formed in the manufacture of TNT which can be the cause of unexpected explosions. For instance, J. M. Weiss[1] points out that technical TNT may contain high nitrated phenols, which form, with metals, unstable salts, and can be the cause of an unexpected explosion. H. Ryan and W. M. O'Riordan[2] perceived that crude TNT usually contains small quantities of β- and γ-isomers, mainly the γ derivative, and is accompanied by some kind of dark amorphous substance which easily explodes when heated; the authors do not suppose it for excluded that this substance may be the cause of unexpected explosions of the technical TNT. Further, for instance, M. Kostevich[3] supposes that the causes of these unexpected phenomena may lie in the mixture of substances which he calls "TNT tarry matter," and which usually accompany the technical TNT if it was not sufficiently purified.

All above-named authors may certainly be right about it, and then in the inference of their presuppositions, the possibility of unexpected explosions of TNT should fall off if this product were always sufficiently purified, (by Kostevich), if the purest materials only were used for its production, and if the intermediate mononitrotoluene were freed in practice by distillation of those "tarry matters" before further nitration.

The question arises if the TNT, carefully freed of all impurities, is capable of changes which might lower its stability respecting its sensitiveness in a disadvantageous practice. If we review the investigations appertaining up to this time to the TNT made there, we find that it does not mean a substance which would especially resist the effects of different chemical agents. Concentrated alkaline solutions cause a deep decomposition of TNT which, as Dupré[4] pointed out, easily lead to ignition, and even to explosion. According to Copisarow[5], even dilute alkalies have some effect. Strong oxidising agents, for instance, the nitrating mixture, on heating,

easily changes TNT into trinitrobenzoic acid and eventually into trinitromethane, as was shown by Giua[6], Will[7] and Langenscheidt[8]. Even sunlight also affects entirely pure TNT, because changes which take place here are already apparent. That TNT varies in colour between yellow, yellowish-red and dark brown, has been known for a long time. H. Kast[9] pointed out that the point of solidification of TNT after fourteen days' action of sunlight, was lowered from 80.0° C., to 79.5° C. F. M. Vasquez[10] reports on the browning of TNT under the influence of daylight, but he states that the other qualities do not change. (?) E. Molinari and F. Quartieri describe in their book, "Notices sur les Explosifs en Italie" (Milan, 1913), on page 167, experiments which they undertook with the illumination of TNT and at which the original—at 80.4° C. melting and 0.03% insoluble residue in acetone—substance shewed after a longer exposure to sunlight, a melting point of only 76.6° C., while its insoluble residue rose to 0.1%; in the same book, Molinari and Giua state that the m.p. of pure TNT after three months' exposure to sunlight in air, was lowered to 74° C., while another sample of the same material illuminated under the same conditions, but in an evacuated glass tube, shewed a much less intense colouration, and a m.p. only 0.6° C. lower than the original substance. H. Custis[10] states that sunlight causes oxidation of TNT and affords proofs that the U-rays act quicker. Finally, Oddo[12] mentions that TNT on exposure to light becomes acid, and capable of oxidising alcohol.

Independently of these observations, as early as the beginning of the year 1916, one of us began to study (during his time at the former military establishments for the manufacturing of explosives at Blaumau, near Vienna), the changes in TNT which arise by the action of sunlight, and came to the opinion that among the photoreaction products is very probably picric acid. Picric acid is indicated in the alkaline exeracts of the light brown TNT by the colour reactions, and with dye tests on wool, etc. More thorough and systematic experiments in this direction were postponed owing to circumstances.

As is seen in the above-mentioned literature, no one hitherto has worked on the chemical characteristics of the products which are formed by the action of sunlight on TNT. Therefore our experiments were carried out in this direction, *i.e.*, we exposed entirely pure 2, 4, 6 trinitrotoluene to the direct action of sunlight, then we examined the products formed. As will be mentioned below, we at first isolated from the mixture of these photoreaction products, only trinitrobenzoic and picric acids, while the identification of the other substances which also formed was postponed, mainly for the scarcity of material on the one hand, and for the long time which is necessary for the exposition of light on the other. For further tests with TNT the illumination which would offer us sufficient quantities of the material for the study of other, and unknown reaction products, we used the U-rays instead of sunlight. The results of these very interesting experiments which are not yet finished will be given later.

Being satisfied with the proved presence of trinitrobenzoic and picric acids in the photoreaction products, we first proceeded to study the influence of these two substances on TNT sensitiveness. For this purpose we compared the sensitiveness to shock of the original entirely pure TNT and of TNT subjected to sunlight, as well as of the pure TNT to which we added different quantities of trinitrobenzoic or picric acids.

In our latest work the experiments are divided into three groups, *i.e.*, the experiments on the illumination of TNT and the isolation of the products; the preparation of the necessary trinitrobenzoates and picrates; and finally, the experiments on sensitiveness.

EXPERIMENTS ON THE ILLUMINATION OF TNT.

As elementary raw material, we used the technical tritrotoluene made in the Nobel Dynamite Factory in Bratislava. This material was good for all conditions required in practice. The substance was purified by crystallisation from hot alcohol to the constant m.p. of 81.4° C.; for this a double crystallisation was usually sufficient. The pure substance was always filtered by strong suction, and spread on filter paper in a thin layer and left to dry in the air in the dark for about 12 hours (*i.e.*, during the night), then finished drying (again in the dark), for several weeks in a desiccator above concentrated sulphuric acid.

In this manner, almost snow-white TNT was obtained in the form of fine needles, and this was used for the illumination experiments. For this purpose the substance was equally spread in a thin layer on a crystallising basin, protected from dust, etc., by a glass cover. Basins so arranged

were placed in an open window, directly in a sunny place. Already after several hours it was possible to see the slight turn to yellow which, with the advance of time, became more intense and slowly changed to brown. In order to obtain as much action as possible from sunlight, the TNT layers in each basin were occasionally thoroughly mixed.

(a) EXTRACTION WITH WATER.

After fourteen days of illuminating, we extracted a sample with water, first in cold and then in boiling. By this method we gained yellow coloured solutions evidently reacting acid and colouring on adding soda or alkaline solutions, intensely red, and coagulating with acetic-nitrone solution. The residues from the water extraction, (whether in cold or in warm) remain darkly coloured, from which it is seen that the extraction was not perfect.

The fact that TNT becomes acid by the action of light points to an oxidising reaction which would be in full agreement with the above-mentioned observation of Custis.

(b) EXTRACTION WITH POTASSIUM HYDRATE SOLUTION.

Supposing that the acid reacting products of oxidation to be more easily soluble in alkalies than in water alone, we tried to extract the exposed TNT with a dilute (about 50%) potassium hydrate solution. This gave an intensely dark red solution, from which dark tarry matters separated after several minutes. Also, even the residue which was insoluble in the extracting liquid was almost black brown, *i.e.*, disproportionately darker than formerly. These circumstances also point to the origin of some kind of tarry matters which are formed by the influence of the alkali. A similar appearance may also be observed when KOH acts on the purest TNT alone, again in agreement with the above-mentioned observation of Dupré and Copisarov. Therefore, it is plain that it is not possible in this case to use alkali hydrates as solvents and it is necessary to find a weaker agent.

(c) EXTRACTION WITH SODA SOLUTION.

We even tried to use as extracting liquid a 10% sodium carbonate solution, with which we shook out three time a sample of exposed TNT. Although we did not get the total colour from the extracted sample, yet we noticed that, contrary to the original brown colour, it became remarkably pale. The soda solution, which was intensely red, we made acid with dilute sulphuric acid, by which dark brown flocks separated and the liquid changed to a dark yellow colouration. The dark sediment, here separated, we considered contained no important impurities; therefore we filtered it off and neglected it. The filtrate was then extracted with ether, the dark yellow extract was dried with anhydrous calcium chloride and freed from ether by vacuum distillation at laboratory temperature. The resulting residue was dark red and greasy, soluble in alcohol, giving an intensely coloured solution and giving with barium, silver and mercury salts, almost black precipitates. The main part of the ether extract was dissolved in alcohol and precipitated with a 10% alcoholic solution of silver nitrate in excess; the dark sediment, settled on the second day, was suspended in water and decomposed by hydrogen sulphide. After separating the precipitated silver sulphide by filtration, we shook out the filtrate with ether and freed the extract from it by distillation under diminished pressure. The yellowish red residue was so little that it was scarcely sufficient for the test tube reactions. Dissolved in alcohol, it gave with barium and potassium hydroxide solutions, an intense dark red colouration and was precipitated by mercury nitrate and nitrone-acetate as flocky sediments.

As it seems even the soda solution acts on the illuminated TNT unfavourably, we decided to use sodium bicarbonate for the next extraction experiments. Even the purest TNT is coloured in the shortest time, pink to red, by contact with normal sodium carbonate solution, while the bi-carbonate solution under the same conditions remains colourless, even after several days.

(d) EXTRACTION WITH SODIUM BICARBONATE.

For further experiments in which we used TNT exposed quite four months (from November to February) and whose m.p. was lowered from the original 81.4° C. to 73.5° C., we proceeded as follows: 20 gr. of the brown substance was dissolved in 50cc of perfectly pure benzene and the dark solution was extracted twice with about a double volume of a 5% sodium bicarbonate solution. The original brownish red benzene solution was at once discoloured almost completely, by which it was possible to judge that the larger quantity of the photoreaction products passed into the aqueous solution. The benzene solution yielded, after evaporation

to dryness, only slightly yellow-coloured TNT, melting at 79.9° C., proving that almost all impurities, *i.e.*, in our case the photoreaction products, are nearly entirely removed.

The reddish-brown bicarbonate solution was acidified with dilute sulphuric acid, whereby a dark brown sediment was precipitated. This was placed on a filter and washed with alcohol to remove everything except a very small black and greasy residue. The intensely yellowish-red alcoholic solution gave, on adding an alcoholic silver nitrate solution, a pink sediment, which appeared to be chiefly silver sulphate. To the filtrate from this sediment, an aqueous mercurous nitrate solution was added, producing a dark red and flocky precipitation. After standing several days, the flocks were changed into reddish needles almost 15 mm. long. This substance was filtered on a Gooch crucible, dried in dessicator and weighed (yield 2.88g). Heated on platinum foil, the crystals melted and volatilised without igniting.

The main part of this crystalline substance was finely spread, suspended in water and freed by hydrogen sulphide from mercury. The excess of hydrogen sulphide was removed by a current of carbonic acid, whereupon it was filtered and the filtrate extracted with ether. The ether extract was dried with calcium chloride and evaporated to dryness at laboratory temperature under diminished pressure; thus a light brown crystalline residue was gained, which was dissolved in a minimum amount of cold alcohol. To the orange-coloured alcoholic solution an aqueous soda solution was added, thus it acquired an intense blood-red colour and a small amount of insoluble flocks separated. From these it was filtered, the filtrate was acidified with dilute sulphuric acid (by which it was almost completely discoloured) shaken out with ether and the ether extract, after drying again, was evaporated to dryness under diminished pressure at laboratory temperature. The residue was dissolved in a small amount of alcohol, and the solution divided into two parts.

To one part a slight excess of alcoholic silver nitrate solution was added, thus a dark sediment was produced. This was separated on a filtering crucible, dried and analysed by determining silver in the form of silver chloride:

0.1815 g substance gave 0.0582 g AgCl = 0.0483 g Ag = 24.13% Ag.

Theory for silver trinitrobenzoate $C_7H_2N_3O_8$ Ag = 29.66% Ag.

In spite of the remarkable difference in the results with the theory, it is still probable that in the given case no other salt than the (of course, very impure) trinitrobenzoate of silver is formed.

In order to prove the correctness of this opinion, we tried to change the given substance into trinitrobenzene by boiling it with water. For this purpose the second part of the alcoholic solution was diluted with 100cc distilled water and then boiled under a reflux condenser for 1 hour. After cooling, the pale solution was shaken out with ether and the ether extract was evaporated on the waterbath to dryness. Thus a yellowish crystalline residue resulted, which was mixed with a small quantity of microscopic black-brown balls, easily seen with a magnifying glass. In order to remove these impurities, the substance was dissolved in alcohol, the solution was boiled with boneblack, then filtered, concentrated, and left to crystallise. After two days' standing, the faintly yellowish solution deposited fine colourless scales, which were still slightly greyish coloured after suction. This colouration was due to some microscopic black-brown balls, which were seen in a larger measure before the first crystallisation. Therefore the substance was submitted to one more crystallisation from boiling alcohol and was spread on a porous plate to dry. The product was then almost entirely white. It was necessary to give up the further crystallisation for lack of material. For the same reason the elementary analysis also was not carried out, and we limited ourselves to determing its melting point only.

For this purpose we used three capillary tubes, of which one was filled with the tested substance, the second with a mixture of equal parts of this substance and of the entirely pure 1, 3, 5-trinitrobenzene, and the third with TNB alone. These points of melting were observed:

I. The tested substance 115° C. (corrig. 116.7°),
II. Mixture of the substance with TNB 119° C (corrig. 120.9°).
III. Pure TNB (trinitrobenzene) 119° C. (corrig. 120.9°).

As by the colour reactions, even so with the analysis of the silver salt (although considerably impure), it follows that the *presence of 2, 4, 6-trinitrobenzoic acid in the photoreaction products of 2, 4, 6-trinitrotoluene may be considered as proved.*

(To be Continued Next Week.)

ELECTROLYTIC SOLUTION OF COPPER.

By ROBERT SAXON, B.Sc.

As a preliminary to the study of the electrolytic dissolving of copper pyrites $CuFeS_2$ and the subsequent electrolysis of the solution, iron pyrites is first submitted to the current.

ELECTROLYSIS OF IRON PYRITES.

This is not a good source of Iron in the ordinary way, as the irremovable sulphur makes the metal earthy brittle. Well powdered pyrite is places at the bottom of a jar covering a flat cathode of iron, the anode being gas carbon, and the electrolyte weak sulphuric acid (10%). After one hour running with a voltage of 15, the liquid, when filtered from the disintegrated carbon, consists of ferrous and ferric sulphates, the former predominating.

If the anode be changed for one of iron, this rapidly passes into solution, and the electrolyte consists of ferrous sulphate only. Now, as the sulphuric acid has little or no appreciable action on the iron, and certainly none on the pyrite, being too dilute, *even when nascent oxygen is pressed into service*, it seems a farily well established fact that the action is due to the electric current. Indeed, these experiments are intended to show that the charges on the electrodes increases the power of the acid anion, and enables the chemist to make a weak acid a stronger reagent than a strong one in the ordinary way.

Thus a *soluble iron salt* may be obtained *free from sulphur* from pyrite, which may be used along with other electrolytes as ammonium sulphate and chloride to give the metal (Burgess and Hambuechan).

Using an iron anode, solution of the same proceeds rapidly and of the pyrite slowly, but if a resistant alloy such as ferrosilicon or ferrochrome be used, the mineral gives up its iron much more readily as sulphates, and in five hours the ferric salt forms 54% of the mixture. As there is no evidence of deposited sulphur, the following is probably what takes place :—

$$H_2 \cdot H_2SO_4 \quad FeS_2 \quad 2H_2O—X \quad O_2$$

$FeSO_4$ formed.

(The carbon electrode is shown black and the iron anode X. The anode is placed to the right and the cathode to the left. The ions torn away at the ends of the chain touch the electrodes and are de-ionised. New copules are formed between the dotted lines.)

Then the ferrous sulphate reacts with other sulphuric acid to form the ferris sulphate thus :—

$$H_2 \cdot - H_2SO_4 \quad 2FeSO_4.H_2O - X - H_2O$$

$Fe_2(SO_4)_3$ formed.

The heat of formation of $FeSO_4Aq.$ is 2356K, $Fe_2(SO_4)_3$ 6184K, giving a difference of 1472K for the SO_4, assuming that the heat of solution is the same per $2FeSO_4$ as for $Fe_2(SO_4)_3$. The heat of solution of the first is probably about 700K and the second 1700 K where FeSO is present, and these quantities divided in each case by the molecular weight gives roughly 4.5 in each case. The presence of $FeSO_4$ assisting the solution of $Fe_2(SO_4)_3$ possibly brings about an association of these two along with water before the ferric sulphate is given off.

ELECTROLYSIS OF COPPER PYRITES.

This is carried out with electrodes of ferrochrome. The powdered copper pyrites lies at the bottom of the jar round the cathode. The electrolyte is dilute sulphuric acid (10%). The liquid soon takes on the bottle green tint due to ferrous sulphate, and a scum of copper sulphide floats on the surface. The delivery of ferrous sulphate is quicker than with iron pyrites alone. The action takes place probably as follows :—

$$H_2—H_2SO_4 \quad FeSCuS \quad H_2O—O$$

($FeSO_4$ and H_2S are in solution and CuS is deposited.

If the action be continued for six hours, minute quantities of $CuSO_4$ may be detected, but the liquid is opaque green and no traces of the ferric sulphate are found. If the electrolyte be removed and the current be reversed, the CuS on the anode is driven off and deposited as copper on the new cathode. So long as the copper pyrites last there is not much chance of depositing copper, but when that is finished, the sulphide is electrolysed and the metal deposited. There is also ferric sulphate

formed, but not in great proportion. Probably the cuprion in copper pyrites carries negative charge, and is not in the cuprosion form as Cu_2S, for the undoubted tendency is to form $FeSO_4$, and no $Fe_2(SO_4)_3$. It is quite possible that the H_2S is oxidised to H_2SO_4.

General Notes.

MICA IN CANADA.

Practically all the mica produced in Canada is phlogopite, or the amber variety. Deposits of muscovite, or white mica, are also found but the dikes carrying this latter type are usually small and in many cases the mica crystals found in them are worthless for most purposes on account of physical imperfections.

All the mica produced is obtained from two comparatively small areas, one in Ontario, the other in Quebec. The Ontario area lies to the south-west of the city of Ottawa, between the towns of Sydenham and Perth; most of the Quebec deposits lie immediately to the north-east of Ottawa, and the centres of both districts are located at not more than seventy-five miles from Ottawa. Formerly much of the mica was obtained from numerous small workings operated by farmers in the slack season, but now production is practically confined to some half-dozen large operators, who also trim their product and function as dealers, buying up the output of the small operator.

The preparation of mica for the market is entirely a hand process, in which most of the work is done by girls. After most of the waste and adhering rock has been removed at the mines, the mica is sent to the trimming shop, where the thick plates are split into thin sheets and the edges trimmed to remove all waste, broken or brittle mica.

According to the Dominion Bureau of Statistics at Ottawa, the quantity of mica despatched from the mines during 1924 totalled 3,317 tons, worth $286,645, a decrease of 208 tons in quantity, and $40,329 in value. The quantity of scrap mica marketed showed a considerable decrease to a total of 5,541,356 pounds, or approximately 598,000 pounds less than in 1923. This material is ground and used extensievly in the manufacture of prepared roofings. Exports of rough cobbed and thumb-trimmed mica from Canada increased materially, while mica splittings exported decreased 43 per cent.

H.M. TRADE COMMISSIONER'S OFFICE, WINNIPEG.--CHANGE OF ADDRESS.

With reference to the list of H.M. Trade Commissioners and Imperial Trade Correspondents published from time to time, it is notified that the building in which H.M. Trade Commissioner's branch office at Winnipeg is situated will be known in future as Royal Bank Building, instead of Union Bank Building.

Communications for the branch office should accordingly be addressed in future to 703, Royal Bank Building, Winnipeg.

THE UNITED STATES TRADE AND INDUSTRY.

A seasonable trade expansion in the United States is under way, with increased production in basic industries. Good crop weather continues. Commodity prices moved sharply downward during the last fortnight. The official mid-August cotton report forecast of the yield is 13,990,000 bales, against 13,566,000 bales a fortnight earlier. Cotton ginned prior to August 16 was 577,081 bales, against 185,901 a year ago. Car loadings for the week ended August 15 were 1,064,793, a seasonal record, against 1,051,611 in the preceding week, and 953,408 for the corresponding week a year ago. Crude petroleum production for the week ended August 22 averaged 2,120,850 barrels daily against 2,117,750 in the preceding week, and 2,037,700 a year earlier.

RECOMMENDED SPECIFICATION FOR LIMESTONE, QUICKLIME, LIME POWDER AND HYDRATED LIME FOR USE IN THE MANUFACTURE OF SUGAR.

Circular of the Bureau of Standards, U.S.A. George K. Burgess, Director.

Abstract.

Lime is used in the sugar industry either to precipitate impurities from the juices or syrups or, in the Steffen process, to precipitate the sugar from impure solutions. For the former purpose either lump quicklime or hydrated lime may be used; for the

latter purpose very finely ground quicklime, known as lime powder, is required. For the purification of juices, 85 per cent. purity is required of the lime or hydrate or of the limestone from which they are made. When used in the Steffen process, lime powder must contain 90 per cent. sugar soluble lime, and the quicklime or limestone used in making it must be correspondingly pure.

Use of Lime in the Sugar Industry.

(*a*) *Use of Lime Products.* Lime is used in the sugar industry either to precipitate impurities from the juices or syrups, or, in the Steffen process, to precipitate the sugar from impure solutions. For the former purpose either lump quicklime or hydrated lime may be used; for the latter purpose, very finely ground quicklime, known as lime powder, is required. When the process requires the addition to the juice of an excess of lime which is afterward precipitated by carbon dioxide, the sugar manufacturer usually finds it economical to buy lime and carbon dioxide together in the form of limestone.

(*b*) *Kind of Products Required.* This industry requires the purest grade of high calcium lime products which can be economically obtained. Lime powder in particular must be exceptionally pure as well as finely ground.

Limestone.

(*a*) *Definition.* Limestone used in the manufacture of sugar consists essentially of calcium carbonate.

(*b*) *Use of Limestone.*—Limestone is calcined to carbon dioxide and quicklime in a suitable kiln. The size of the stone depends upon the type of kiln. For a shaft kiln the stone should be uniform in size to permit uniform calcination and not too fine, lest the draught be choked. An exceptionally pure grade of stone is required if lime powder is to be made.

Quicklime.

(*a*) *Definition.* —Quicklime as used in the sugar industry is the product resulting from the calcination of limestone and consists essentially of calcium oxide. It will slake when water is added to it, and this slaking is accompanied by an evolution of heat and an increase of volume.

(*b*) *Use of Quicklime.*—Quicklime can be slaked to form milk of lime, which is used to precipitate impurities from the juices, or it can be ground to form lime powder for use in the Steffen process. Pure high calcium lime is required in either case.

Lime Powder.

(*a*) *Definition.*—Lime powder is finely divided quicklime.

(*b*) *Use of Lime Powder.*—Lime powder is added to cold diluted molasses in the Steffen process to precipitate calcium saccharate, leaving the impurities in solution. For this purpose is must be properly calcined, very fine, and exceptionally pure. Even air-slaking renders lime inactive for this purpose.

(*a*) *Definition.*—Hydrated lime is a dry powder which is made by treating quicklime with enough water to satisfy its chemical affinity under the conditions of manufacture. Hydrated lime as used in the sugar industry consists esenstially of calcium hydroxide.

(*b*) *Use of Hydrated Lime.*—Hydrated lime is added to the juice in the dry form, or it is mixed with thin juice or with water to make milk of lime, which is used to precipitate impurities from the juice or syrup.

Packing.

(*a*) Limestone is shipped in bulk in carload lots.

(*b*) Quicklime is shipped either in bulk in carload lots or in barrels holding 180 pounds net or 280 pounds net each.

(*c*) Lime powder must be shipped in airtight containers.

(*d*) Hydrate lime is generally shipped in paper bags holding 50 pounds net each.

Marking.

Each carload of material or fraction thereof shall be legibly marked with the names of the consignor and consignee and with some means of identifying the particular contract on which the shipment is made.

Composition.

Lime products shall meet the following requirements as to chemical composition when the sample is taken at the point of delivery and when the result of analysis are calculated to a nonvolatile basis :

	Sugar soluble lime min.	Magnesium oxide max.	Loss on ignition max.
Limestone[1] for Steffen process	90	3*	—
Limestone for other purposes	85	3	—
Quicklime for Steffen process	90	3	2
Quicklime for other purposes	85	3	5
Lime powder	90	3	2
Hydrated lime	85	3	—

[1] Limestone is calcined before analysis (see Methods of Test).

SIZE.

(*a*) The size of limestone for shaft kilns shall be a matter of contract between the stone producer and the sugar manufacturer. A tolerance of 2 inches above or below the specified size of stone is allowable.

(*b*) Lime powder shall be of such size that 98 per cent. of it will pass a No. 200 sieve, but not so fine that it will " ball " when rotated in a 40-mesh bolter at 20° C.

(*c*) Hydrated lime shall be of such size that 98 per cent. of it will pass a No. 200 sieve.

SAMPLING.

(*a*) *Bulk Shipments.*—The sample shall be so taken that it will represent an average from all parts of the shipment. One shovelful shall be taken from each 3 tons of material, but not less than 10 shovelsful per shipment. The sample thus taken shall be broken to 1-inch pieces, mixed, and " quartered " to provide a 15-pound sample for the laboratory.

(*b*) *Packages.*—Three per cent. of the number of packages shall be selected from different parts of the shipment. A sampling tube shall be used which takes a core of not less than one-half inch in diameter. The tube shall be so inserted into the package, so as to take a core of the material being sampled from substantially the entire length of the package. Material thus taken from individual packages shall be thoroughly mixed and " quartered," and the sample for testing shall not be less than 15 pounds taken from the material so drawn and prepared.

(*c*) *Precautions.*—Quicklime, lime powder, and hydrated lime are apt to air-slake. Sampling must, therefore, be conducted as expeditiously as possible in a cool, dry place, and the container for the laboratory sample must be sealed air-tight immediately after it is filled.

TESTING.

(*a*) *Calcination of Limestone.*—Crush the sample to pass a No. 100 sieve. Put approximately 10 g. in a platinum crucible, and ignite to constant weight at a temperature of 1,000 to 1,100° C., preferably in an electric furnace. The product obtained by this ignition is to be analysed to determine the chemical composition of the limestone.

(*b*) *Sugar Soluble Lime.*—If the material to be tested is quicklime, grind to pass a No. 100 sieve. Place a 5.000 g. sample in a 200 cc. flask with 75 to 90 cc. of freshly boiled distilled water. Boil gently for 3 minutes. Cool to room temperature. Add 40 to 45 g. of commercial white granulated sugar (sucrose) completely dissolved in 40 cc. of hot freshly boiled distilled water. Shake vigorously with a rotary motion of the flask, keeping the lime in suspension for 30 minutes. Fill to the mark, mix and filter, rejecting the first runnings. Pipette off 100 cc. of the filtrate and titrate with 1,785 normal nitric acid (1 cc. = 0.050 g. CaO), using phenolphthalein as indicator. The cubic centimetres of acid used, multiplied by 2, equals the percentage of sugar soluble lime in the sample as tested. Convert into per cent. on nonvolatile basis.

(*c*) *Magnesia.*—The magnesia determination is made after removing silica, iron oxide, alumina, and lime. Ignite 1 g. of the sample strongly in a platinum crucible for 15 minutes. Cool, and weigh to obtain weight of nonvolatile sample taken. Moisten the residue and dissolve it in 1 : 1 hydrochloric acid, evaporate to dryness on the steam bath, take up in 5 cc. of hydrochloric acid, add 50 cc. of water, and filter off the silica. To the filtrate add 5 cc. of hydrochloric acid, then make it slightly alkaline with ammonia, heat to boiling, and filter off the oxides of iron and aluminium. Acidify the filtrate slightly, heat to boiling, add ammonium oxalate slowly to excess, then ammonia slowly until in slight excess. After the precipitate has settled for one to two hours, filter and wash with an ammoniacal ammonium oxalate solution. Reserve the filtrate. Ignite the precipitate. When cool, moisten it, dissolve in hydrochloric acid, and reprecipitate. Filter off the calcium oxalate, washing with ammoniacal ammonium oxalate

solution. Discard the precipitate, combine the filtrate with the first one, slightly acidify with hydrochloric acid, and add an excess of microcosmic salt. Then slowly add ammonia until a crystalline precipitate forms or the solution is alkaline. Finally add one-fifth of the volume of ammonia water in excess. After the precipitate has fully formed, preferably by standing overnight, filter and wash with dilute ammonia water (5 per cent. by volume). Dissolve the precipitate in a slight excess of hydrochloric acid, add one or two drops of phosphate solution, and reprecipitate by adding ammonia while stirring, finally adding 2 or 3 cc. of ammonia in excess. Filter, wash with 5 per cent. ammonia, and ignite to constant weight. Weight of magnesium pyrophosphate × 0.3621 = weight of magnesium oxide.

(*d*) *Loss of Ignition.* -Ignite 1 g. of the sample in a platinum crucible to constant weight at a temperature of 1,000 to 1,100° C.

(*e*) *Fineness.*- -Weigh out 20 g. of lime powder or hydrated lime, transfer to a No. 200 sieve, and brush the material carefully with a camel's hair brush until practically no more powder passes through. Transfer the coarse residue to a weighing capsule or watch glass and weigh. Multiply the weight by 5 and deduct from 100 to obtain the percentage passing the No. 200 sieve. If desired, the powder may be spread in a thin layer in the sieve, heated for 15 mins., in an air bath at 100 to 110° C., and while still hot brushed through the sieve as described above. All sieves used in testing shall meet the requirements of the United States Standard Sieve Scale, Bureau of Standards Letter Circular 74.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section B.--Chemistry.

THE CHEMISTRY OF SOLIDS.

ADDRESS BY PROFESSOR CECIL H. DESCH, D.Sc., Ph.D., F.R.S., President of the Section.

(Continued From Last Week.)

This possible effect of very minute quantities of impurities reminds us that we know exceedingly little of the properties of pure solids. Gases and liquids, which we commonly assume to be easily obtained in a pure state, have been shown, especially by Baker, to alter greatly in properties when deprived of their last traces of moisture, and this is true to some extent even of solids, Baker having found that specimens of sulphur and iodine had their melting points raised by 5.5° and 2° respectively when submitted to intensive drying for nine years. Another illustration may be taken from the effect of dissolved gases on metals. Most metals as cast contain very considerable quantities of gases, either in true solution or trapped during freezing by the growth of neighbouring crystals, and these gases are not removed completely in the later operations of forging or rolling. The effect of gases on the physical properties of the metal has been little studied, but that it may be great is shown by the instance of soft iron used for transformer cores. Either commercially pure iron or the alloy of iron with silicon which is commonly used for this purpose is enormously improved in its magnetic properties by melting in a high vacuum and extracting the dissolved gases as completely as possible. The hysteresis loss is reduced to a quarter or less of its original value by this treatment. Pure iron so freed from gases is almost as soft as copper. The magnetic properties seem to be more profoundly altered than any others, but there is evidently a wide field here for investigation.

Impurities other than gases may exert an influence out of all proportion to their quantity if concentrated in the boundaries between the crystal grains. When the added element is insoluble, or practically so, in the metal, the effect is obvious, as in the famous instance of gold to which 0.01 per cent. of bismuth has been added, the soft and ductile gold becoming excessively brittle, as shown by Roberts-Austen as a lecture experiment. Even when the two metals are miscible in the solid state it is quite possible that there may be a concentration of the impurity at the boundaries, if the addition be one which lowers the surface tension of the metal, it having been shown that surface tension plays an important part in the determination of those boundaries. Traces of oxide or sulphide are naturally rejected in freezing, and Tammann has found that when cadmium is dissolved in a solution of ammonium nitrate without the evolution of gas, a fine network of insoluble matter is left, representing the outlines of the crystal grains. Even if we imagine a metal so carefully purified that all these possibilities have been eliminated, it still does not follow that

the mass is chemically homogenous. There must be some change in the condition of the space lattice as the boundary is approached, and whether we suppose that this disturbance is limited to a layer a few atoms thick, or assume, as Brillouin and Rosenhain have done, that there exists an amorphous intercrystalline layer of appreciable thickness, one must conclude that there will be some chemical difference at the boundaries, and this is confirmed by the effect of etching reagents, which commonly indicate a difference in the rate of etching between the mass of a crystal grain and its boundary. Chemical reagents differ widely in this respect. Some brasses are readily brought into a state of brittleness, in which the crystal grains break away from one another under shock or alternating stresses, and it is usually possible to bring about the separation by contact with a suitable chemical reagent. It appears likely that failure in practice most often begins under the influence of chemical corrosion. The remarkable feature of this kind of failure is that it is only caused by a few chemical reagents, and that others will attack the metal generally without any selective action on the boundaries of the grains. Two reagents have in a striking degree this property of attacking the boundaries first - ammonia and the salts of mercury. The latter act with extraordinary rapidity, so that specimens of brass may be found which will disintegrate completely into a mass of loose grains, like sand, within a few seconds after immersion in a solution of mercurous nitrate. On the other hand, nitric acid or ferric chloride will attack the same brass uniformly, as if the condition of intercrystalline brittleness were totally absent.

When a face of a crystal is brought into contact with an etching reagent, such as water for rock salt, hydrofluoric acid for quartz, or cupric ammonium chloride for iron, the surface is not dissolved away evenly, leaving it smooth, but characteristic etching pits are produced, the sides of the pits being evidently crystal faces. This shows that chemical action proceeds more readily along certain planes of a crystal than along others, a fact which we should not expect from the general properties of the space lattice. It is not explained, however, why these etching pits should appear at first separate from one another, the intervening portions of the surface being unattacked. Minute portions of some impurity, causing local electrolytic differences, suggest themselves as a possible cause, but it is unlikely that they would be so evenly scattered in, for instance, a quartz crystal as to produce the regular distribution which is often observed. Minute inequalities of level, which may be of a periodic character, are more probable, and this suggestion is strengthened by the observation that a polished face of rock salt dissolves evenly in water, whilst a natural cleavage face shows etching pits.

Lastly, another cause of want of homogeneity in solids is the presence of portions which have been deformed beyond their elastic limit. Such deformation alters the electrolytic potential of a metal, so that a couple is set up between the deformed and undeformed portions, even bringing about action in otherwise remarkably inactive iron of high purity used by Lambert in his experiments on corrision. A true theory of corrosion will have to account for the formation of etching figures in apparently homogeneous substances.

It is now possible, when pursuing the study of solids, to eliminate one of the disturbing factors, the intercrystalline boundary, by making experiments with specimens composed of a single crystal. There are several ways of preparing single metallic crystals of such a size as to allow of the determination of their physical and mechanical properties. Carpenter and Elam have strained sheets of pure aluminium in tension, producing a permanent elongation, and this sheet, after suitable annealing, shows such a remarkable increase of size of its crystal grains that frequently one occupies the whole, specimen. Czochralski's method is to dip a silica point into slightly undercooled molten metal, and then to raise it by clockwork at a rate which just keeps pace with the growth of the crystal, thus obtaining a thin cylindrical specimen. Davey has prepared large single crystals of copper by allowing the molten metal contained in a tube to freeze slowly from one end, whilst tungsten filaments of great length have been prepared by suitable thermal treatment during and after drawing. All of these specimens have been studied, their great ductility being a characteristic feature. Even so brittle a metal as zinc has an extraordinary ductility in single crystals. The mechanism of deformation has been studied by Taylor and Elam, zinc and tin by Polanyi and his colleagues, and tungsten by Goucher. There is now a large body of evidence as to the directions

of slip in a crystal during deformation, and this knowledge is essential to any understanding of the nature of cohesion, with which the chemical properties are no doubt closely connected.

We may now turn to the subject of chemical reactions which take place in the interior of a solid, either originating at the surface or from nuclei which make a spontaneous appearance in the course of cooling below the melting point. A chemical change which has begun at some point in or at the surface of a homogeneous crystalline mass cannot advance unless the atoms are able in some way to change their places. Gross movements, represented in gases and liquids by convection currents, are out of the question, but the slower process of diffusion, by which atoms or molecules can make their way through the solid, must be possible. Only by assuming the reality of diffusion in solids can one explain the changes brought about in metallic alloys by heating and cooling, or the structure of minerals in igneous rocks. No very refined observations are necessary to establish the fact of diffusion, although quantitative measurements in this field are difficult. A large steel forging which has cooled slowly shows, when etched, triangular markings which recall the Widmanstatten figures seen in meteorites and are, in fact, of similar origin. From a solid solution in which carbon is uniformly distributed throughout the crystals of iron, almost pure iron has separated in these characteristic bands, leaving the carbon concentrated in the remaining material which fills the meshes. For such a structure to be produced, some of the atoms of iron or carbon, or both, must have travelled through the crystalline steel over distances of the order of a millimetre in the course of some hours. Experiment shows that diffusion in solids, whilst naturally a slow process in comparison with diffusion in liquids, proceeds at quite measurable rates, the distribution of the invading atoms at different distances from their place on entrance following the familiar law, so that a coefficient of diffusion may be calculated from analytical results or from microscopical observations. The classical example of such measurements, and for many years the only one, is the study of the diffusion of gold in solid lead, undertaken by Roberts-Austen in 1896. It was then shown, and the figures have since been confirmed by a very accurate series of determinations by Van Orstrand and Dewey, that gold diffuses into liquid lead at 200° at a rate which is 1/420 of that at which it diffuses into liquid lead at 550°. This is not the best pair of metals which could have been chosen, as lead and gold form compounds with one another, so that something more than mere physical diffusion is involved, but the choice was an obvious one, on account of the delicacy of the analytical methods of determing the distribution of gold in successive layers. Even at 100° the diffusion has a measurable value. A much simpler example is that of silver and gold, two metals which resemble one another closely in chemical character and in atomic volume, so that diffusion causes less change of properties than in any pair of less closely similar metals. The experimental results prove, as might have been anticipated, that diffusion is a much slower process when there is so little difference in chemical character. The value of the coefficient of diffusion varies with the condition of the experiment, a solid solution which contains much of the diffusing element offering a far greater resistance to diffusion than does the pure solvent metal. The same is true of other pairs of metals, and of the diffusion of carbon into iron, a process of the highest technical importance. When the two kinds of atoms are closely alike, the tendency to diffuse must be small, but it is certainly not zero. By making use of an ingenious device, Hevesy has been able to determine the coefficient of self-diffusion of liquid and solid lead. Two isotopes should not differ appreciably in their rates of diffusion, so that when the radioactive isotope thorium B is allowed to diffuse in ordinary lead the experiment is equivalent to selecting a certain number of lead atoms and attaching labels to them by which they may be identified in the course of their journey. In this way he found that the diffusion in liquid lead near to the melting point was of the order of that of salt in water, but that in the solid state it was very small. Further experiments, using a thin foil, proved that at 2° below the melting point the rate was 1/10000 of that in molten lead. The same method has been used to determine the rate of diffusion of radioactive elements through gold, silver, and platinum.

The matter is, however, by no means simple. On the one hand, inter-diffusion at the junction of two metals proceeds in both directions, although sometimes at

very unequal rates. Dr. J. W. Jenkin, working in my laboratory, has been able to show that at 1,000° copper diffuses into solid nickel about twenty times as fast as nickel into copper, the observed diffusion curve being the sum of two curves of similar type. A further complication arises from the fact that ordinary laboratory specimens of metal consist of an aggregate of crystalline individuals, the axes of which are directed at random, so that the whole mass is considered for ordinary purposes as though it were isotopic. It is unlikely that foreign atoms can travel with equal ease in all directions in a crystal, and the observed diffusion will be an average value. Now that single crystals of many metals are available it is natural that experiments on diffusion in solids should have been made with them, and the results are rather surprising. Geiss and van Liempt found that neither molybdenum nor iron diffused into wires consisting of single crystals of tungsten, even when the temperature was near to the melting point of the more fusible metal, whilst mixed powders of the two metals became completely homogeneous on being heated for a few hours at the same temperature. In a similar way, Hevesy has found that his radioactive isotopes do not diffuse appreciably through a sheet consisting of a single crystal of lead. An explanation has been offered, based on the assumed existence of a layer of amorphous material between the crystalline grains. It is supposed that diffusion through the mass of the crystal does not occur, and in favour of this view Hevesy notes the fact that in different specimens of lead, varying in the size of their crystal grains, diffusion was much slower in that which had the largest grains, and therefore the smallest proportion of intercrystalline substance. On the other hand, microscopical observation of such pairs of diffusing metals as copper and nickel prove that the advance of the diffusing metal, as shown by the change of colour, proceeds through the whole mass, and not merely along the boundaries. Indeed, it is hard to see how any mass of metal could become homogeneous if diffusion were confined to inter-granular boundaries, as it is certain that the position of those boundaries may remain unchanged throughout the whole of the experiment. Hevesy finds that polonium, which is not isotopic with lead, diffuses through lead foil or through a single crystal of lead at the same rate, and suggests, as he has done regarding diffusion in solids in general, that the process is one of loosening of the space lattice, the invading atoms travelling through the progressively loosened patches. It remains to be seen whether the X-rays afford any support for this view. On the other hand, it may be suggested that much will depend on the particular crystal face selected for an experiment, as it is certain that if true diffusion through a crystal be possible—and I fail to see how such an assumption can be dispensed with it must be much easier in the direction of certain crystalline planes than across them. This point calls for a systematic examination.

(To be continued).

BRITISH ASSOCIATION OF SCIENCE 1925 (SOUTHAMPTON) TRANSACTIONS.

Abstracts of Papers.

(Continued from Last Week.)

Mr. D. Brunt.- *Periodicities in Weather.*

The paper gives a discussion of the results derived from a periodogram analysis of twelve sets of meterological data each extending over at least 100 years. The data used are temperature at London, Edinburgh, Milan, and Padua; and pressure at Edinburgh and Paris. The periodograms are given in detail in a paper read (in title) at the Royal Society in June, 1925.

It is found that no periods over 10 years in length are common to all the records, but some short periods, of lengths between 13 and 60 months, occur in a number of temperature records, with sensibly the same phase. An 11-year period, which may be the sunspot period, occurs in the Edinburgh temperatures, but in none of the other records, though a period of between 22 and 23 years, which may be the double sunspot period, occurs in several of the records.

Each of the periodograms shows a large number of peaks, indicating a large number of possible periodic variations, and in view of the difficulty of assigning accurate values to the phase and amplitude of each period it is considered improbable that these results can be utilised for forecasting the weather at any future time.

(To be Continued.)

NOTICES OF BOOKS.

L'Hydrogène et les Gaz Nobles par J. J. VAN LAAR. Pp. 80. Leiden: A. W. Sijthoff, 1925.

The Dutch Chemical Society has, for a long time, published works of general interest in a language (English, French, or German) that will admit of a wider public than they would command if they appeared in Dutch only. These memoirs are to be found in the monthly, *Receuil des Travaux Chimiques des Pays-Bas.*

The monograph under review is the first of a series to be issued from the same source and it to be followed by two, in English, dealing with the *Configuration of the Saccharides* (*by* M. J. BOESEKEN), and *Oxidation Limits* (by W. P. JORISSEN and J. VELISEK). A chapter is devoted to each of the gases H, He, Ne, Ar, Kr, Xe, and Nt. There is also a final chapter which constitutes a resumé of the group.

Each chapter gives an account of the determinations of the atomic weight, normal volume, critical points, and other physical properties of these elements in the light of the results of the latest researches in this field. An appendix includes the advances made in our knowledge of these gases since 1922.

Although the treatment is mathematical the monograph will prove of value to advanced students and research workers for whom it is intended.

J. G. F. D.

Apologia Alchymiæ, by R. W. COUNCELL. Pp. XII. + 88. London: J. M. Watkins. 21, Cecil Court, Charing Cross Road. 1925. Price 5s.

There are comparatively few modern books dealing with the early history of chemistry, and no apology is needed for further critical works on alchemy.

The present one by Mr. R. W. Councell is intended for scholars and enthusiasts rather than for the general public. Indeed, the edition is limited to five hundred copies. The claims of the early chemists upon our attention is set forth largely in their own words in the form of quotations.

He considers that the law of evolution obtains in the mineral and metallic realm, as well as in the biological world and that this may have been the means whereby the alchemists were able to effect the artificial formation of gold.

The alchemist, Mr. Councell argues, did not require metals, or their ores, in order to obtain this much-sought treasure. He regards some, at least of the claims of transmutations into gold as genuine. While a few alchemists can be shown to be impostors, it is difficult to include such a man, for instance, as J. B. van Helmont (1577-1644) among their number. Van Helmont definitely claimed to have obtained nearly 8 ounces of gold from that amount of mercury.

In my *Brief History of Science* (published by *The Chemical News*), which naturally deals with alchemy as well as other phases of early science, attention is directed to those claims of the alchemists, which cannot be dismissed as fantastic. Closer study in the future should lead to the elucidation of the problem.

The preface to Mr. Councell's book was written in 1923 by Sax Rohmer, whose query is, " What are our modern advances? Do we give full credit to those who preceded us? "

To all but the very keen, alchemical literature is dull reading. It is frequently obscured with mystical notation. When it has been more fully investigated, our present estimation of those early workers may undergo considerable modification

J. G. F. D.

A System of Physical Chemistry, by WILLIAM C. McC. LEWIS, M.A. Vol. II. Thermodynamics, with diagrams. 490 pp. Price 15s. net. Longmans Green and Co., 39, Paternoster Row, London.

In his brief preface to the fourth edition of Volume II., the author points out that opportunity has been taken of making further corrections and amendations, and of introducing here and there short accounts of the more recent investigations of the applications of thermodynamics to chemistry; for instance, an account has been introduced of the rôle of the thermodynamic conception of " activity," especially in relation to solutions. The introduction of improvements of various kinds in new editions as ancillary to the main object which is invariably to replace an exhausted edition conduces to the intrinsic value of a book, and this is certainly the case in the present instance.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co, Regd Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

22,047.—Austerweil, G.—Preparation of menthol from p-cymene. September 3rd.

21,969.—Cassella and Co., Ges. L.—Production of arsenic compounds of the aromatic series. September 2nd.

21,939.—Millberg, C.—Preparation of phosphoric acid. September 2nd.

Specifications Published this Week.

238,621.—Robinson, C. S.—Production of oxides of sulphur.

238,668.—Westinghouse Lamp Co.,—Extraction of metals from their compounds.

226,500.—Michalski, K.—Process and apparatus for the manufacture of carbon monoxide and hydrogen.

224,525.—Schieb, G.—Process for obtaining pure sinalbin mustard oil.

238,825.—Soc. Chimique Des Usines Du Rhone.—Process of manufacture of acetic anhydride and aldehyde.

Abstract Published this Week.

237,100.—Anthraquinone derivatives. —Fierz, H. E., 2, Bondlerstrasse, Kilchberg, near Zurich, Switzerland.

Pure 1-nitro-2 methylanthraquinone is obtained from the crude product by heating its aqueous suspension with a sulphite, *e.g.* sodium sulphite. The isomers pass into solution in the form of sulphonic acids and can be removed by filtration. The purified product gives immediately with sodium sulphide pure 1-amino-2 methylanthraquinone, the bromine and other derivatives obtained therefrom being stated to melt at 40-50° C. higher than has hitherto been stated.

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DECOMPOSITION OF TRINITROTOLUENE BY THE ACTION OF SUNLIGHT.

By PROFESSORS C. KRAUZ AND O. TUREK.

(Continued from Last Week.)

The acid and dark yellow-coloured filtrate which was left after precipitation of the bicarbanote extract by sulphuric acid, we shook out several times with ether and the united ether extracts were dried with calcium chloride and then freed them from ether by distillation. The light-brown residue was dissolved in alcohol and to the solution was added an alcoholic solution of silver nitrate. This precipitated a small quantity of a voluminous pinkish sediment, again shown to be silver sulphate. This was filtered off and to the filtrate an aqueous mercurous nitrate was added. Thereby the liquid became clouded and after several days it separated a small quantity of little reddish-yellow crystals, which were collected on a filtering crucible and weighed. The whole (0.0235 g) was boiled with dilute sulphuric acid, the mixture was cooled and shaken out with ether ;evaporated to dryness, the ether solution leaving a dark red residue which, after addition of dilute KOH solution, was still coloured red. A part of this residue was dissolved in a small quantity of chloroform, the solution was mixed with another of anthracene in chloroform, and the mixture was evaporated to dryness, which yielded an undesirable yellow substance. Inasmuch as it is possible to judge from the tests with the small quantity of substance, it seems to be probable that mercurous trinitrobenzoate was here precipitated, of course, considerably impure.

The intensely yellow filtrate which remained after the crystals, we acidified with dilute sulphuric acid, by which the main part of the silver and mercury sulphates were precipitated. Then we shook out the mixture with ether. Even at the first extraction the solution was almost entirely discoloured, and sinstead of it, the ether layer wa coloured. The ether extract was now dried and evaporated to dryness. A small part of the residue was dissolved in chloroform, mixed with a solution of anthracene in chloroform and then evaporated to dryness, at which it left a residue with blood-red finely crystalline edges, characteristic of anthracene picrate. In order to prove more certainly the presence of picric acid, we dissolved the main part of the substance in alcohol, and added to it a nitrone solution in dilute acetic acid. At this an abundant yellow voluminous sediment was precipitated which we filtered off and recrystallised from alcohol and determined its melting point, viz., 260° C. (corrig. 271.8°). To make quite sure, we proceeded similarly as with the trinitrobenzene first isolated, *i.e.*, the one capillary tube was filled with the tested substance, the second with the mixture of this substance and the pure nitrone picrate, and the third with the nitrone picrate alone, whereupon we heated all the three at the same time in a common bath of concentrated sulphuric acid. Thereby we noticed these melting points:

I. Tested substance 262° C. (corrig. 271.8°),
II. Mixture of both substances 263° C. (corrig. 272.8°),
III. Nitrone picrate alone 261.2° (corrig. 271.3°).

Like the colour reaction with anthracene, so the determination of the melting points are considered sufficient proof of the presence of picric acid in the exposed trinitrotoluene.

With the proof of the presence of trinitrobenzoic and picric acids in the exposed TNT, the first part of our investigations ended. In its continuation we paid attention, first to the quantitative part and we tried to find out in what relation (to

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the original TNT on the one hand, to one another on the other hand), both these acids are formed. But at this stage the scarcity of suitable methods by which these substances could be separted from one another analytically, hindered the work.

To describe here the new analytical methods would, of course, be unnecessarily long. Information about this will appear elsewhere and we confine ourselves here to the description of those experiments by which the presence of the two acids in TNT take part in the sensitiveness.

II.

Preparation of Metal Picrates and Trinitrobenzoates.

Wishing to try how far the effect of picric and trinitrobenzoic acids on the sensitiveness of TNT to shock, we were obliged first of all to prepare both acids in sufficient quantities and then to form their metallic salts.

(a) The Picric Acid and Its Salts.

As raw material we used technical picric acid which we purified by crystallisation from hot alcohol until a constant melting point of 122° C. was attained. From the entirely pure acid we then prepared the series of following picrates:

Mercurous picrate, by precipitation of aqueous picric acid solution with mercurous nitrate and drying at 100° C. (0.3160 g of the substance gave 0.1705 g HgS = 46.50% Hg, the theory for $C_6H_2(NO_2)_3OHg$ requires 46.80% Hg.)

Mercuric picrate, from picric acid and mercuric oxide according to Varet[13] (and by drying at 130° C.) (0.1898 g of salt yielded 0.0677 g HgS what corresponds to 30.80% Hg, the theory for $(C_6H_2(NO_2)_3O)_2Hg$ requires 30.55% Hg.)

Lead picrate, in precipitating the acid with lead nitrate and drying at 130° C. (0.0599 g of the picrate gave 0.027 g $PbSO_4$, *i.e.*, 30.80% Pb, the theory for $(C_6H_2(NO_2)_3O)_2Pb$ corresponds to 31.15% Pb.)

Cupric picrate, by decomposition of barium picrate with cupric sulphate and drying at 130° C. 0.2257 g of the salt yields 0.035 g CuO, *i.e.*, 12.53% Cu, the theory for $(C_6H_2(NO_2)_3O)_2Cu$ requires for 12.24% Cu.

Nickel picrate, same as the cupric salt. 0.1619 g of the substance gives 0.2880 g NiO = 11.07% Ni, the theory for $(C_6H_2(NO_2)_3O)_2Ni$ corresponds to 11.40% Ni.

Ferric picrate, according to Kast[11] by double decomposition of silver picrate and ferric chloride, by crystallisation from alcohol and drying at 130° C. 0.2790 g of the salt gives 0.0311 g Fe_2O_3 = 7.82% Fe, the theory for $(C_6H_2(NO_2)_3O)_3Fe$ requires 7.54% Fe.

Aluminium picrate, by boiling picric acid with aluminium hydroxide and drying at 100° C., 0.1726 g of the salt gave 0.0323 g Al_2O_3 = 9.82% Al, the theory for $C_6H_2(NO_2)_3O.Al(OH)_2$ requires 9.37% Al.

Manganese picrate, by double decomposition of barium picrate and manganese sulphate and drying at 130° C., 0.1320 g of the substance gave 0.0385 g $MnSO_4$, *i.e.*, 10.61% Mn, the theory for $(C_6H_2(NO_2)_3O)_2Mn$ requires 10.71% Mn.

Zinc picrate, same as the manganese picrate, 0.1020 g of the salt yields 0.0160 g ZnO = 12.60% Zn, the theory for $(C_6H_2(NO_2)_3O)_2Zn$ requires 12.51% Zn.

Magnesium picrate, by neutralising the acid with magnesium oxide and drying at 130° C., 0.3135 g of the substance gave .00748 g $MgSO_4$, i.e., 4.82% Mg, the theory for $(C_6H_2(NO_2)_3O)_2$ Mg corresponds to 5.04% Mg

Barium picrate, by neutralising of the acid with barium hydroxide and drying at 130° C. 0.2161 g of the substance gives 0.0852 g $BaSO_4$, *i.e.*, 23.17% Ba, the theory requires for $(C_6H_2(NO_2)_3O)_2Ba$: 23.15% Ba.

Calcium picrate, by neutralising the picrate, 0.0980 g of the salt yielded 0.0268 g $CaSO_4$ = 8.05% Ca, the theory for $(C_6H_2(NO_2)_3O)_2Ca$ requires 8.07% Ca.

Potassium picrate, same as the two former salts, 0.1458 g of the substance gave 0.0585 g K_2SO_4 = 14.58% K, the theory for $C_6H_2(NO_2)_3OK$ requires 14.64% K.

Sodium picrate, in the same manner as the potassium salt, 0.1410 g of the salt gave 0.0395 g Na_2SO_4, *i.e.*, 9.07% Na, the theory for $C_6H_2(NO_2)_3ONa$ corresponds to 9.16% Na.

All the previously named metallic picrates whose composition, respecting the degree of purity is given by the mentioned analytical results, were kept above concentrated sulphuric acid before using.

(b) The 2, 4, 6-Trinitrobenzoic Acid and its Salts.

For the preparation of the trinitrobenzoic acid from TNT according to G. Lüttgen, we oxidised with nitric acid and potassium chlorate. The separated crystal mass was then filtered by sharp suction, the solid was extracted in the cold with sodium car-

bonate solution, filtered off from the insoluble part, and the filtrate was acidified with sulphuric acid. This separated almost snow white scales which were drained and dried on a porous tile. They melted at 210° C.

The transformation of trinitrobenzoic acid in its salts is not, of course, so simple a matter as for picric acid. As is known, the trinitrobenzoic acid is very easily decomposed at higher temperature, giving up the carbonic acid and changing into trinitrobenzene. This decomposition easily occurs even in aqueous solution, at slightly elevated temperatures, so that it is impossible to apply here the most simple method, *i.e.*, neutralisation of the acid solution saturated with the corresponding metallic hydroxide or carbonate and by crystallisation from hot water. For this reason, it seems, salts of trinitrobenzoic acid also were not (except some rare cases) hitherto prepared.

The preparation of metallic trinitrobenzoates and the study of their properties, therefore, forms a separate work which we do not intend to enlarge upon unnecesarily in this paper as we give information about it elsewhere. Here we only mention a small list of those trinitrobenzoates used. The composition of these salts is proved by the adjoined analytical results.

Mercurous trinitrobenzoate. $C_6H_2(NO_2)_3COOHg$. 0.1961 g of the substance gives 0.0990 g HgS, *i.e.*, 43.48% Hg, the theory requires 43.92%.

Mercuric trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Hg$. 0.6075 g of the salt gave 0.1973 g HgS = 28.02% Hg, the theory requires 28.15%.

Lead trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Pb$. 0.2170 g of the salt yields 0.0980 g $PbSO_4$, *i.e.*, 28.92% Pb, the theory requires 28.81%.

Cupric trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Cu.2H_2O$. 0.6385 g of the substance gave 0.1210 g CuCNS, *i.e.*, 9.90% Cu and 0.1455 g of the same salt lost by drying 0.0090 g = 6.18% H_2O, while the theory requires 10.10% Cu and 5.80% H_2O.

Nickel trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Ni.2H_2O$. 0.1856 g of the salt gives 0.0225 g NiO, *i.e.*, 9.53 % Ni and 0.2431 g loses by drying 0.0692 g = 5.57% H_2O, the theory corresponds to 9.67% Ni and 5.93% H_2O.

Ferric trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Fe(OH).2H_2O$. 0.0797 g of the substance gave 0.0100 g Fe_2O_3, *i.e.*, 8.77% and 0.4626 g of the alt lost by drying 0.0246 g = 5.32% H_2O, the theory requires 8.99% Fe and 5.80% H_2O.

Aluminium trinitrobenzoate. $C_6H_2(NO_2)_3COO)_2Al.OH$. 0.2183 g of the salt gives 0.0192 g Al_2O_3 = 4.62% Al, the theory corresponds to 4.86% Al.

Manganese trinitrobenzoate. $C_6H_2(NO_2)_3COO)_2Mn$. 0.1707 g of the salt gives 0.0437 g $MnSO_4$, i.e., 9.32% Mn, theory requires 9.17% Mn.

Zinc trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Zn$. 0.1832 g of the salt gave 0.0260 g ZnO = 11.40% Zn, theory requires 11.32% Zn.

Magnesium trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Mg.H_2O$. 0.1983 g of the substance gives 0.0460 g $MgSO_4$ = 4.69% Mg and 0.2175 g of this salt loses by drying 0.0075 g = 3.45% H_2O, theory requires 4.58% Mg and 3,25% H_2O.

Barium trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Ba$. 0.2265 g of the salt gives 0.0930 g $BaSO_4$ =21.15% Ba, theory requires 21.16% Ba.

Calcium trinitrobenzoate. $(C_6H_2(NO_2)_3COO)_2Ca$. 1.4602 g of the substance gave 0.3796 g $CaSO_4$, *i.e.*, 7.65% Ca, theory corresponds to 7.25% Ca.

Sodium trinitrobenzoate. $C_6H_2(NO_2)_3COONa.3H_2O$. 0.1925 g of the salt gives 0.0475 g Na_2SO_4, *i.e.*, 7.99% Na, and 0.3157 g of the same substance loses by drying 0.0505 g = 16.00% H_2O, theory requires 8.24% Na and 16.22% H_2O.

Potassium trinitrobenzoate. $C_6H_2(NO_2)_3COOK$. 0.1837 g of the substance gives 0.0555 g K_2SO_4 = 13.56% K, the theory corresponds to 13.25% K.

III.

Sensitiveness Experiments.

For these experiments we used the usual impact machine with 2 kg weight. For each single stroke we weighed 0.1 g of the given substance, which was then always wrapped in thin 3/3 cm. tin foil so that each envelope then took every time an equal surface of 1 cm². Each of the drops always gave six strokes and this was registered the amount of the fall, or of the partly, or eventually of no explosion. The criterion of sensitiveness was always taken as considered drop in centimetres by which 2 kg. gave at least one full explosion.

Altogether we made three series of these tests. We compared first of all the influence of the addition of picric acid and its salts in quantities of 5 ,10, and 20 per cent of pure

dry trinitrobenzoic acid and its salts. Besides we also tried to test the TNT illuminated in the sun regarding its sensitiveness part on the one hand alone, and on the other with addition of the same metal oxides. The results of these experiments we arranged in tables and then constructed adjoined curves from them.

(*To be Continued Next Week.*)

THE STRUCTURE OF MAGNESIUM.

By Hawksworth Collins, B.A. (Camb.).

In the *Chemical News*, 1914, CIX., 26; 1920, CXXI., 157; and 1924, CXXVIII., 81; the constitution of an atom of Mg was given as NaH. This is equivalent to C_2 by the Inter-relationship of the Elements (C.N. 1920, CXX., 169).

This constitution will now be proved to be correct quite independently by means of the laws of relative volume and heat of formation.

Table I.

The Relative Volumes of Magnesium.

(1)	Mg(24)	=	Na(23)	+	H(1)
(2)	7.51	=	6.54	+	0.97
(3)	Mg(24)	=	C(12)	+	C(12)
(4)	8.71	=	8.0	+	0.71
(5)	13.69	=	8.0	+	5.69
(6)	14.565	=	13.855	+	0.71
(7)	19.545	=	13.855	+	5.69
(8)	27.71	=	13.855	+	13.855
(9)	13.855	=	13.855	+	0.

All these part-volumes, except 13.855, have frequently been given before.

Table II.

Experimental Data Illustrating Table I.

		Relative Volume.	Theor S.G.	Obs. S.G. at 15° C.	
(10)	$MgFe(CO_3)_2$	7.51 + 10.08 + 2(20.55) where 20.55 = 8.0 + 7.53 + 2(2.51).	3.41	3.412	Breithaupt
(11)	$MgCa(CO_3)_2$	7.51 + 14.54 + 2(20.55)	2.914	2.914	Neumann
(12)	$MgCO_3$	7.51 + 20.55	2.994	2.9 3.1	Chem. Kal.
(13)	$MgHPO_4.3H_2O$	7.51 + 5.76 + 26.54 + 3(14.03)	3.124	3.123	15° Nostrand
(14)	$MgPtBr_6.12H_2O$	7.51 + 9.05 + 6(23.09) + 12(14.03)	2.807	2.802	Topsoe
(15)	$MgSO_4$	8.71 + 15.53 + 2(7.53 + 2.51)	2.708	2.709	15° Thorpe
				2.706	Playfair and J.
(16)	$MgO.MgCO_3.3H_2O$	8.71 + 2.51 + 8.71 + 20.55 + 3(14.03)	2.156	2.152	International
(17)	MgO	8.71 + 2.51	3.565	3.5699	0° Ditte
(18)	$CaMg(CO_3)_2$	14.54 + 8.71 + 2(20.55)		2.89	Ott
			2.86	2.85	Senft
(19)	MgF_2	8.71 + 2(5.42)	3.17	3.15	Sella
(20)	$MgCl_2.6H_2O$	8.71 + 2(15.085) + 6(14.03)	1.65	1.65	Ochsenius
(21)	$Mg(OH)_2$	½(8.71 + 7.51) + 2(2.51 + 5.76)	2.353	2.36	15° Schulten
(22)	Mg	13.69	1.75	1.75	Deville
(23)	$MgCl_2$	13.69 + 2(15.085)	2.17	2.177	Playfair and J.
(24)	$MgCO_3.3H_2O$	13.69 + 20.55 + 3(14.03)	1.808	1.808	18°/18 Nostrand
(25)	Mg	13.855	1.732	1.71	17° Kopp
				1.743	5° Bunsen
(26)	$MgCl_2$	14.565 + 2(15.085)	2.13	2.177	Playfair and J.
(27)	$MgSO_4.7H_2O$	14.565 + 15.53 + 2(7.53) + 2(2.51) + 7(14.03)	1.66	1.660	Playfair and J.
(28)	$MgKCl_3.6H_2O$	19.545 + 22.29 + 3(15.085) + 6(14.03)	1.62	1.618	Chem. Kal.
(29)	$CaMg_2Cl_6.12H_2O$	12.24 + 2(19.545) + 6(15.085) + 12(14.03)	1.666	1.6655	Van't Hoff
(30)	$MgSeO_4.6H_2O$	19.545 + 36.85 + 6(14.03)	1.956	1.955	15°.2 Pettersson

(36.85 is the volume of SeO_4 in many other compounds)

TABLE III.

	Heat of Formation of Mg							Original Volume		Rel. Vol. in combination		Change of Volume
(31)	58260	=	120	×	20.2	×	24	27.71	=	7.51	+	20.2
(32)	54760	=	120	×	19.0	×	24	27.71	=	8.71	+	19.0
(33)	37858	=	120	×	13.145	×	24	27.71	=	14.565	+	13.145
(34)	aq. 59190'											

TABLE IV.

		H.F. in large calories.				Rel. Vol.
(35)	Mg	58.260	=	4	×	14.565
(36)	Mg	54.760	=	4	×	13.69
(37)	C	13.886	=	1	×	13.855

The three relations in Table IV. are additions to those already given in the papers on Sulphur and Selenium; where it was noticed that the H.F. of an atom is frequently equal to a simple multiple of one of its relative volumes. The last relation is not quite exact, but it will be taken for the future as an exact relation, 13.855 being on both sides of the identity, for the following reasons: The whole of this theory (this word is here used in the same sense as in "The Theory of Quadratic Equations") has been discovered by the observation of a great many series of concordant results, *e.g.*, the difference between the relative volumes of K and Na was found to be 10.44 in several cases. No hypothesis was made as to what were the relative volumes of K and Na which produced this difference; but it was found later by many concordant results that the volume of K was 22.29 and that of Na 11.85.

The H.F. = 13886 for C was found as nearly as possible from experimental data, but the rel. vol. of C as a constituent part of an element has been found in Nos. 6-9 to be exactly 13.855; and since it has been observed, as mentioned above that the H.F. of an element is frequently a simple multiple of a rel. vol. of the same element, the conclusion is attained that the exact H.F. of an atom of C is = 13855 small calories. This value will therefore be employed for the future as correct to five figures.

TABLE V.

Experimental Data Illustrating Table III.

	Heat of Formation.		Theor.	Obs.	
(38)	$Mg.C.O_3$ 58260 + 13855 + 32341 + 2(96155)	=	269025	269900	266600
	(Corresponds with No. 10.)				
(39)	$Mg.F_2$ 54760 + 2(76820)	=	208400	208100	209500
	(Corresponds with No. 19.)				
(40)	$Mg.O.H'_2O$ 54760 + 96155 8205	=	147710	148960	
	(Corresponds with No. 17.)				
(41)	$Mg.O_2.H_2$ 54670 + 2(96155) 2(15800)	=	216470	217800	
(42)	$Mg.O.H'_2O$ ½(54760 + 58260) + 96155 8205	=	149460	148960	
(43)	$Mg.O_2.H_2$ ½(54760 + 58260) + 2(96155) - 2(15800)	=	218220	217800	
	(Corresponds with No. 21.)				
(44)	$Mg.Cl_2$ 37858 + 2(56786)	=	151430	151010	
	(Corresponds with No. 26.)				
(45)	$Mg.S.O_4$ 37858 + 6217 + 2(32841) + 2(96155)	=	301067	301500	300900
	(Corresponds with No. 27.)				
(46)	aq.$Mg.S_2.H_2$ 59190 + 2(49959) - 2(24350)	=	110408	110860	
(47)	aq.$Mg.Cl_2$ 59190 + 2(63870)	=	186930	186930	
(48)	aq.$Mg.Br_2$ 59190 + 2(52930)	=	165050	165050	
(49)	aq.$Mg.I_2$ 59590 + 2(37720)	=	134630	134630	

(50)	aq.Mg.O.SO_3 59190 + 96155 + (96155 − 71515)	=	179985	180180	
(51)	aq.S.O_3 6217 + 2(32341) + 71515	=	142414	142410	T
(51A)	aq.Mg.S.O_4 59190 + 6217 + 2(96155) + 2(32341)	=	322399	321780	
(52)	aq.H_2.S.O_4.H'_2O − 2(24350) + 6217 + 2(96155 + 32341) − 3205	=	211304	210770	T
(53)	aq.H.Cl − 24350 + 63870	=	39520	39150	T
(54)	aq.H.N.O_3 − 24350 − 23300 + 3(32341)	=	49373	49090	T
(55)	aq.Ba.O_2,H_2 72134 + 71515 + 117460 − 2(15300)	=	230509	229260	
(56)	Ba.S.O_4 81926 + 0 + 2(96155 + 32341)	=	338918	339400	
(57)	aq.K.O.H. 36100 + 96155 − 15300	=	116955	116460	T
(58)	aq.K_2.S.O_4 2(37274) + 6217 + 2(96155 + 32341)	=	337757	338000	
(59)	aq.Ba.Cl_2 72134 + 2(63870)	=	199874	199210	
(60)	aq.Ba.N_2.O_6 72134 − 2(23300) + 6(32341)	=	219580	219000	
(61)	aq.H_2.S − 2(24350) + 56176	=	7476	7290	T
(62)	liq. H_2.O − 2(24350) + 117460	=	68760	68360	Thomsen
				69000	Berthelot

Heat of Solution.

When (44) produces (47),

37858 becomes 59190
2(56786) becomes 2(63870)

(63) 2(63870) − 2(56786) + 59190 − 37858 = 35500 35920 T

Heat of Neutralisation.

When (43) and (52) produce (51A) and three times (62),

56510 becomes 59190
2(96155) becomes 2(117460)
2(−15300) becomes 2(−24350)
−3205 becomes 0

(64) 59190 − 56510 + 2(117460 − 96155) − 2(24350) + 2(15300) + 3205 = 30395 31220 T

Heat of Decompostiion.

When (51A) and twice (53) and (62) produce (47 and (52), the only change is :—

0 becomes − 3205

(65) Total change − 3205 − 2592 Thomsen

Heat of Neutralisation.

When (43) and twice (53) produce (47) and twice (62),

56510 becomes 59190
2(96155) becomes 2(117460)
2(−15300) becomes 2(−24350)

(66) 59190 − 56510 + 2(117460 − 96155) − 2(24350) + 2(15300) = 27190 27690 Thomsen.

Heat Solution of Metal.

When Mg and twice (53) form (47) and H_2,

0 becomes 59190
− 2(24350) becomes 0

(67) 59190 + 2(24350) = 107890 108290 Thomsen

The facts concerning this last particular chemical operation are taken as an example to show that, in each one of all the similar cases in this and other papers, the volume and alteration in volume of each one of the several elements concerned has been exactly discovered. The Mg-atom descends from vol. 27.71 to 7.16 thereby evolving 59190 calories. The two chlorine atoms remain unchanged. Each H.atom descends from volume 8.59 to 0.97, as explained in the paper on Active Hydrogen.

It is necessary to remember that each atom of Mg actually decreases in size in the proportion of 27.71 to 7.16; but that each atom does not evolve 59190 calories. It is a gram-atom that does this.

The volume 7.51 is correct for 7 independent reasons :

(A1) It can be split up into two parts (No. 2) in accordance with the law of relative volume;

(A2-A6) It occurs five times in Table II., each of which is independent of the others;

(A7) It gives the same original volume as the other two values of H.F. in Table III.

Similarly, 8.71 is correct for eight, 13.69 for five, and 14.565 for six independent reasons.

SUMMARY.

The intricate interdependence of facts demonstrated in this paper makes it absolutely certain that the correct interpretations of the varied phenomena have been deduced.

The only *apparent* flaw in the proof is the fact that the original volume of the element, required by the law of heat of formation, is double the volume obtained by experiment. But the fact that it is exactly double, and also that the same original volume is required in all three cases in Table III., proves without any doubt whatever that no flaw exists, but that the apparent discrepancy is due to something which has not yet been discovered.

The clue to this state of affairs happens to appear in an article in the *Chemical News*, 1925, CXXXI., 2, by Martin Meyer on the "Preparation of Zinc Diethyl," as follows : "Should the reaction fail to start, as occasionally happens, it may be necessary to distil all of the ethyl iodide over into B and *reheat the zinc for a few minutes.*" This means that the reheating of the zinc puts the element temporarily into a state which is different from its normal state as an element .

Applying this hint to the case of our present problem concerning Mg, and taking all the observed facts into consideration, it is evident that an atom of Mg in the metallic state normally has a relative volume of 13.885, *i.e.*, one half of the element is completely absorbed by the other half (No. 9) But when heated the absorbed part is ejected, so that each atom has a temporary volume of 2(13.855) = 27.71.

In addition to demonstrating the structure of Mg by means of three sets of experimental data, *viz.*, At.wt., S.G., and H.F., this paper accomplishes the following objects :—

(B1) It continues the reduction of the experimental data of S.G. to exact instruments of research.

(B2) It strengthens the Law of Relative Volume.

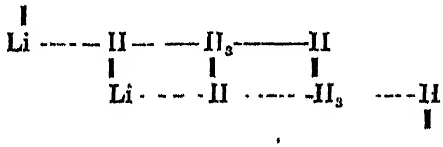
(B3) It strengthens the Law of Heat of Formation.

(B4) It demonstrates the causes of Thomsen's observed experimental effects, not necessarily of his calculated effects.

(B5) It continues the demonstration that water of crystallisation *absorbs* heat when formed from liquid water, especially in Nos. 64, 65, and 66.

(B6) It continues the demonstration that it is impossible to *calculate* the H.F. of any substance (as Thomsen did) with any certainty of its being correct without the previous knowledge of the relative volume of each atom forming the substance.

The structure of an atom of Mg by this and many previous papers is



where the top line is C, the bottom line is also C, the right-hand portion is H, and the left is Na. The thick lines denote valences, and the thin lines represent atomic bonds, which are not chemically evident. Some of these latter bonds (not represented) also unite the top and bottom lines.

General Notes.

THE COAL MINING INDUSTRY IN RUSSIA.

The revival of the coal industry in the Union of Soviet Socialist Republics started about 1921, and developed to such an extent—much faster than the metallurgical industry—that by 1924 large stocks had accumulated and output was greater than consumption, states Mr. P. Gent, of the British Mission in Moscow, in a report to the Department of Overseas Trade. Exports to Mediterranean countries and the Near East—commenced in 1924 at prices below cost—discontinuance of imports and a wide campaign for fostering the home consumption of coal, all failed to bring demand to the level of production. During the spring of 1925, output was therefore curtailed, shafts were closed, and workers dismissed. During the last month or two, particularly in view of good harvest prospects, symptoms have become manifest of a more rapid economic recovery, especially in industry—even in the metallurgical industry, which is the most backward. June output of coal showed a marked increase over May, owing chiefly to the increased productivity of labour and partly to mechanical improvements. This increase, coinciding with the compiliation of bigger industrial output and increased railway traffic plans for 1925-26, has not aroused concern. On the contrary, it is declared that fuel demands next year will exceed the supplies foreseen by fuel plans. In June, 128,710 persons were employed in the coal mining industry.

ELECTRIC STORAGE BATTERY LOCOMOTIVE COMPETITION.

Colonel G. R. Lane-Fox, M.P., Secretary for Mines, announces that the judges appointed to adjudicate on the above competition for a prize of £1,000 which was offered by Mr. Charles Markham, of Ringwood Hall, Chesterfield, for the best type of locomotive for use underground in coal mines, have arrived at their decision. They award the whole of the prize to Messrs. Joseph Booth & Brothers, Ltd., engineers, Union Foundry and Ironworks, Rodley, Leeds, whose design fulfilled the conditions of entry, and was, in their opinion, the best that was submitted to them.

The judges propose to present in due course a report of the competition and a summary of the technical results obtained at the trials under working conditions. This will be published as soon as it is available.

OUR OVERSEAS TRADE IN AUGUST.

Reductions in both imports and exports in August, as compared with the previous month or with August of last year, were but slightly off-set by an increase in the value of re-exports. Out imports of manufactures were more than 15 per cent. under those of a year ago, largely due to the falling off in silk goods.

SPAIN'S FOREIGN TRADE IN 1924.

Imports into Spain last year were valued at 2,947 million pesetas, of which 1,497½ million pesetas represented manufactured goods. Exports totalled 1,748 million pesetas, of which foodstuffs accounted for 992¼ million pesetas. The United Kingdom headed the exporters to Spain with 485 million pesetas.

BONUSES FOR SPANISH SHIP-BUILDERS.

Under the terms of a recent decree the Spanish Government is to pay certain bonuses for vessels built in Spain and for building, repairs, etc., carried out with material imported from abroad for those purposes.

BRITISH IRON AND STEEL PRODUCTION.

Pig iron output in August fell to 444,500 tons from 492,700 tons in the previous month and 510,300 tons in June, while the production of steel ingots and castings was only 477,100 tons as compared with 590,400 tons in July and 585,400 tons in June.

SAMPLES OF CLOTHING, ETC., FOR IRISH FREE STATE.

Regulations governing the temporary duty-free admission of samples of personal clothing and wearing apparel, footwear, blankets and rugs have been issued by the Revenue Commissioners of the Irish Free State.

U.S.A. TEXTILE IMPORTS: THE INCREASE IN RAW MATERIALS.

Imports into the United States of textile fibres and of textiles during the fiscal year ended 30th June last were valued at 971,645,000 dollars, an advance of 101,000,000 dollars, or 11.6 per cent., over the total for the previous twelve months, states " Commerce Reports," the official journal of the Bureau of Foreign and Domestic Commerce branch of the United States Department of Commerce at Washington. The bulk of this increase is accounted for by larger purchases of textile raw materials abroad.

TAXES ON COMPANIES IN HUNGARY.

The British Commercial Secretary at Buda-Pest has forwarded a translation of a Decree (No. 400/P.M.), issued by the Royal Hungarian Minister of Finance relative to the consolidation of all legal regulations with regard to the Company Tax.

Foreign companies are subject to the same treatment and rate of tax as Hungarian companies. The various tax rates in force are enumerated in the Decree.

British firms interested may consult the Decree as translated at the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference 22088 F.W.)

BRITISH MIGRATION IN FIRST HALF-YEAR.

Emigrants of British nationality from the United Kingdom to places outside Europe during the first six months of 1925 exceeded immigrants from those places into the United Kingdom by 27,626. The outward balances for the corresponding period of 1924 and 1923 were 17,412 and 65,053 respectively.

NEW ZEALAND TRADE IN FIRST HALF-YEAR.

While June quarter showed some decline in the rush of imports reported for the first three months of the year, the total for the six months was considerably higher than in the corresponding period of 1924. Exports were well above those of last year. The United States made marked progress in New Zealand's import trade, but the United Kingdom's share was less.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section B.—Chemistry.

THE CHEMISTRY OF SOLIDS.

ADDRESS BY PROFESSOR CECIL H. DESCH, D.Sc., Ph.D., F.R.S., President of the Section.

(Continued From Last Week.)

When a liquid mixture of two substances which are miscible in the solid as well as in the molten condition, such as an alloy of copper and nickel or a fused mass of albite and anorthite, begins to solidify, the composition of the crystals has to adjust itself continuously in order to maintain equilibrium with the changing liquid phase, as was shown by Roozeboom in his classical work on solid solutions. Such an adjustment is only possible by means of diffusion, and when cooling is sufficiently slow, the adjustment does in fact keep pace with the change in the liquid, but with more rapid cooling the interior of each crystal differs in composition from its outer layers, there being a concentration gradient from the centre to the boundary. This condition produces the 'cored' crystals which are familiar to every metallurgist, and the "zoned" crystals of the mineralogist. In most alloys this want of homogeneity disappears after a sufficiently long period of heating at some temperature below that of which the first drops of liquid are formed, but alloys of bismuth and antimony fail to become uniform even after weeks of annealing, whilst the felspars and similar minerals have never been persuaded to lose their zoned structure by any methods known in the laboratory.

Bruni has shown and Vegard has confirmed the observation by the X-ray method, that true interdiffusion occurs between potassium and sodium chlorides when mixed and heated in the solid state. Electrolytic transport is observed in the solid halides of silver and in mixtures of silver and copper sulphides, but the modern view of the structure of such substances represents them as built up of ions rather than of neutral atoms, and this must be taken into account in any interpretation of the facts. The apparent absence of diffusion in minerals which have once solidified, even when given geological periods of time, is a serious difficulty in the way of any general theory of diffusion. Such ex-

amples of the passage of alkali metals through quartz and other silicous minerals under the influence of a difference of electric potential are probably not instances of true diffusion at all, but merely of the passage of traces of impurities through a mass which is not completely impervious. We have always to bear in mind that crystals, whether of natural origin or prepared in the laboratory, are rarely perfect, and may contain cavities and capillary passages through which matter may pass without disturbing the crystalline lattice. This idea of the imperfection of crystals has found an interesting application in the work of A. A Griffith on the rupture of solids and of such semi-solid substances as glass and fused silica. The tensile strength of metals and of these substances is far smaller than would be expected from calculations of the theoretical cohesion of the materials. Griffith supposes that actual solids and glasses contain innumerable fine cracks, which reduce the strength. By special means he has been able to prepare rods of glass and silica in an unstable state, in which their strength and elasticity are enormously greater than in their normal condition. It has even been suggested that means may be found for bringing our ordinary metals and structural materials into a similar condition, which would enable them to withstand loads several times greater than those which are normally possible, although the prospect of a sudden return to the stable condition with its accompanying weakness may alarm the engineer.

However, the use of materials in an unstable conditions is already familiar to metallurgists. Hardened steel is an instance. At high temperatures the structure of most of our steels is homogeneous, the carbon being in solid solution in the iron, which is then in the γ-condition. As the temperature falls, the iron changes into a modification which is stable at lower temperatures, and loses its power of holding the carbon or carbide molecules (for the X-rays have so far failed to determine how the carbon atoms are grouped in the space lattice) in solution, so that separation occurs, and α-iron and cementite, Fe_3C, from the mass, two solid phases now being present in place of one. The scale of the separation may vary greatly according to the time occupied by the process. No separation can occur without diffusion, and the transport of atoms or molecules through the solid mass takes an appreciable time, which is greater the lower the temperature, so that it is much less perfect when the steel is cooled rapidly than when ample time for diffusion is permitted. Consequently, the size of the molecular aggregates of cementite may vary from that of ultramicroscopic particles, so small and offering so large a surface to the action of chemical reagents that the mass is stained black or brown by acids, in which case the mixture is known as trootsite, to the comparatively coarse, although still microscopic scale of the well-known laminated pearlite, in which the thin alternate sheets of ferrite and cementite, like the fine sheets in mother-of-pearl, can produce colours by the diffraction of light, when the pearly appearance noticed by Sorby in the first exact scientific study of the microscopic structure of a metal.

Now let the cooling be so rapid that a distinct separation into two phases, even on an ultramicroscopic scale, does not occur. The rearrangement of the iron atoms in their space lattice, in this instance from the face-centred cubic arrangement of the γ-iron into the body-centred cubic arrangement of α-iron, still takes place, but the crystallisation of cementite as a separate phase is prevented. The result is that a new structure is obtained, known as martensite, in which the iron is, at least for the greater part, in the α-form, as is proved by its X-ray examination and by its magnetic properties, but in which the carbide is held, either in unstable solid solution in α-iron, in which it is normally insoluble, or as sheets of molecules parallel with the octahedral planes of the iron. Both views have their supporters, but I must profess a leaning towards the second. Whichever be correct, it is certain that this unstable condition is associated with great hardness and lack of plasticity, and it is necessarily present in fully hardened steels. Still more rapid cooling may suppress both the change in the lattice and the separation into phases, the solid solution which is stable at high temperatures being preserved during cooling, so that a part of the iron is still in the γ-condition, and holds carbon atoms in a homogeneous fashion within its structure. As such a cooled solid solution is not hard, the steel is actually rendered less hard and brittle when the quenching is so severe than if it had been cooled somewhat less rapidly. The transformation of the iron, however, occurs with such ease that it is only when the proportion of car-

bon is rather large, or when some other metal is present, that this condition can be observed.

It is the addition of foreign metals which has brought about the most remarkable changes in the properties of steels, out of which there has grown a new and important industry that of the alloy steels. The presence of foreign elements in the original solid solution has a powerful influence on the rate of change in the system. As a general rule, the change from one lattice to another and the passage of a constituent, such as carbide, out of or into solution are greatly retarded by the presence of alloying elements, a striking example being that of Hadfield's manganese steel, containing about 12 per cent. of the added metal, the effect of which is to delay the change to such an extent that with fairly rapid cooling the solid solution is perfectly preserved so that the steel is relatively soft, its chief peculiarity lying in the fact that any deformation brings about a partial change, producing the hard martensitic structure wherever there is flow. This is the reason for the extraordinary resistance of the alloy to abrasion, and for other properties which, being mechanical, lie outside the scope of the present discussion.

Only a comparatively small number of metals will produce useful alloy steels. Those metals include, first, the immediate neighbours of iron, namely, cobalt and nickel, which resemble it so closely in most of their properties, and next the A members of the groups VI and VII of the periodic classification, chromium, molybdenum, tungsten and manganese. The next horizontal neighbour of nickel is copper, but it has only a very limited value as a constituent of steel, and its related elements are apparently of no use for this purpose. Uranium, the heaviest metal of the chromium group, does not alloy readily with iron, and the claims which have been made for its beneficial influence have not been confirmed. A small group of non-metals, all near neighbours of carbon, can enter into the composition of steels, namely boron, silicon, nitrogen and phosphorus, all of which have their uses in this connection. Between the two groups lies the metal vanadium, which is very valuable when added in small quantities to steels. It would be of interest to study the two homologues of manganese, the metals having the atomic numbers 43 and 75, the discovery of which has been claimed quite recently, from this point of view if they should ever be found in sufficient abundance. The companions of the ferrous metals in group VIII, the platinum metals, do not appear to form alloy steels of any importance. An alloying element,

B	C	N	O	F					Li
Al	Si	P	S	Cl					Na
	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
	Zr	Nb	Mo		Ru	Rh	Pd	Ag	Cd
	Hf	Ta	W		Os	Ir	Pt	Au	Hg
	Th	Po	U						

to be of value, must be able to enter into solid solution in γ- or α-iron or both, or to form a carbide which can do so. By varying the composition of alloy steels, and by subjecting them to different thermal treatments, a wide range of properties may be obtained, and the number of possible components being so large, it is clear that a very extensive field is offered for investigation. As a rule, only those alloys which lie within certain limits of composition have practical value, but dogmatism on this point is undesirable, and new and unexpected properties may be discovered in a series of alloys when carefully investigated —witness the remarkable discoveries of Permalloy, containing 78.5 per cent. of nickel, the remainder being iron, the ex-

traordinarily high magnetic permeability of which in low fields was quite unforseen and has proved of the utmost value to the manufacturer of cables. The rule given above as to the position of useful alloying elements in the periodic classification holds good, however, and the claims so frequently made for the virtues of some of the rare elements as additions to steel almost invariably prove to be baseless. Other metals than those mentioned may be of some use in the process of manufacture by serving to remove oxygen or some other undesirable impurity, but this is not alloying, the substance used as a 'scavenger' disappearing from the metal in the process and being removed in the slag.

(*To be Continued.*)

FARADAY SOCIETY.

A Relation Between the Velocity of Photochemical Reactions and the Dielectric Constant, by CHR. WINTHER (Copenhagen).

(A contribution to a General Discussion on *Photochemical Reactions in Liquids and Gases*, held by the Faraday Society at Oxford, October 1st and 2nd, 1925.)

The velocity of photochemical reactions, as well as of dark reactions, greatly depends on the nature of the medium in which the reaction occurs, as has long been known in the bleaching of dyes. The simplest relations may presumably be found in cases where the solvent does not take part in the reaction. I have found in the literature only two series of experiments where the solvent has been varied to some extent, namely, the oxidation of iodoform[1] and the polymerisation of anthracene.[2]

Table I. contains in the first column the solvents in which the iodoform was dissolved, in the second the velocity constants v of the photochemical oxidation, and in the third the dielectric constants D of the solvents.

Table II. contains the same data for the polymerisation of anthracene. These values have been calculated (for the temperature 154°) from the original ones with the aid of the temperature coefficient 1.47, found for the solution in phenetol.

[1] Plotnikow, *Z. physik Chem.*, 75, 396 (1911).

[2] Luther and Weigert, *Z. physik. Chem.* 53, 393 (1905).

TABLE I.

Solvent	v.	D.
CCl_4	39.4	2.25
C_6H_6	34.6	2.29
CS_2	24.1	2.61
Ethyl ether	17.0	4.3
Ethyl acetate	8.1	6.11
CH_3OH	3.2	31.2
C_2H_5OH	2.3	25.8
Acetone	0.7	21.5

TABLE II.

Solvent.	v.	D.
C_6H_6	355	2.29
$C_6H_5CH_3$	168	2.33
Xylol	52	2.38
Anisol	18.6	4.35
Phenetol	18.0	ab 4.3

There seems to be a certain relation between the reaction velocities and the dielectric constants of the solvents. With the exception of the last two values in Table I., which are too small to have been measured with great exactitude, the reaction velocity generally decreases with increasecreasing dielectric constant. My intention is only to point out the relation and invite further investigations on this point.

NOTICES OF BOOKS.

The Science of Soils and Manures, by J. ALAN MURRAY, B.Sc., lecturer in agricultural chemistry at University College, Reading. Third edition. Revised and enlarged, 298 + VII. pp. Price 12s. 6d. net. Messrs. Constable, 10-12, Orange Street, London, W.C.2.

The present work, calculated as it unquestionably is, to increase farming efficiency and augment the productiveness of the soil, is of more than passing importance. There is, of course, a wide divergence of opinion among agriculturists as to the values, quantities, mixtures, and proportions of the fertilisers and manures. Hence an authoritative work on the subject is both opportune and welcome, and we are not surprised to learn that the book has found favour with Indian and Colonial planters and cultivators. Indeed, we have to point out with regret that many farmers are apathetic and negligent in keeping pace with progress in agricultural science, to their own loss, as well as that of the community generally.

Principles and Practice of Industrial Distillation, by E. HAUSBRAND. Translated from the fourth new and enlarged German edition by E. HOWARD TRIPP, Ph.D. (Marburg); joint editor of the *Journal of the Society of Chemical Industry*. 300 + XV. pp., with 21 figures, 68 tables, and 16 charts. Price 21s. net. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2.

As the author points out in his preface to the third edition, the subject matter has been completely revised in the present edition. Points that in former editions were left obscure have been clearly elucidated, so that the equations relating to distillation leave little to be desired from the standpoint of derivation, symetrical form and simplicity. In his preface to the fourth edition, the author points out that much supplementary matter has been introduced both in the text and the tables. As an example, a detailed exposition is given of the conditions obtaining in undivided stills of rectifying apparatus and in two-compartment or partitioned stills of the semi-continuous type. It is also pointed out that in the treatment of ethyl alcohol and water, the values of Gröning and Sorel, used previously, have been replaced by those of H. Bergström, whose results virtually agree with the determinations of Lord Rayleigh, Blacker, Margules and Mendeleef.

There is no need for the author to apologise for making the book more bulky by the introduction of tables, charts, and other extensions, for these add materially to the value of this important work.

The Translator has done a difficult task well, and especially as owing to the death of the author, he was deprived of the opportunity invaluable to a translator, of referring difficult and ambiguous points to him.

Photo-Electricity The Liberation of Electrons by Light, with Chapters on Flourescence and Phosphorescence, Photo-Chemical Actions, and Photography, by H. STANLEY ALLEN, M.A., D.Sc., F.Inst.P., F.R.S.E., Professor of Natural Philosophy in the University of St. Andrew's. 320 + 12 pp. Price 18s. net. Longmans, Green and Co., 89, Paternoster Row, London, E.C.4.

The present is the second edition of this important work, the first edition having been published in 1910, since which date a good deal of extraordinary history has been written. Changes in the outlook of science have also taken place. As the author says in his preface to the present edition, although our ideas of atomic structure have been revolutionised by the experimental work of Rutherford, Moseley, Braggs, and others, and while our views have been changed by Einstein's Theory of Relativity, and Planck's Quantum Theory, yet the facts about Photo-Electricity recorded in 1913 remain substantially true at the present time. The present work is, in all respects, up to date, has a number of clear diagrams and possesses a useful index and an exhaustive bibliography.

CORRESPONDENCE.

To the Editor, CHEMICAL NEWS.

PERIODICAL PUBLICATIONS.

Sir,

I am sending herewith a copy of a catalogue of periodical publications currently displayed in these libraries, which I venture to think is quite unique. In addition to giving a complete index and alphabetical index, the catalogue also shows at a glance all the publications dealing with one subject. On page 28, for example, you will see that the periodicals on Chemistry and Chemical Engineering are grouped in one definite order, each entry clearly showing the libraries where the periodical may be seen. But the most important feature of this catalogue is the indication by an asterisk which periodicals are filed, and by number, which periodicals are indexed—the numbers referring to the indexes which are listed on page 2.

Although many periodicals are marked as being filed, as a general rule these periodicals are marked as being filed, as a general rule, these periodicals are discarded after five years; but you will be interested to know that we have a long bound file of your publication. The catalogue is being sent free of all charge to firms in the city and to individuals likely to benefit by having such a list near at hand; and I trust you will consider this rather striking deffparture from ordinary library practice worthy of special notice in the columns of your Journal.

Yours faithfully,
CHARLES NOWELL,
City Librarian.

Public Libraries.
Gulson (Central) Library,
Trinity Churchyard,
City of Coventry.
12 September, 1925.

COMING EVENTS.

SOCIETY OF PUBLIC ANALYSTS

AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, October 7, at the Chemical Society's Roms, Burlington House, Piccadilly, W., at 8 p.m.

The following papers will be read :—

Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates :

III.—*A New Method for the Separation of Tantalum from Niobium.*

IV.—*The Detection and Determination of Tantalum in Niobium Compounds.*

ByA. R. POWELL AND W. R. SCHOELLER, Ph.D.

The Determination of Sulphates in Guncotton. By H. B. DUNNICLIFFE, M.A., D.Sc., F.I.C.

The Reduction of Chloric Acid and Chlorates by Ferrous Sulphate. By C O. HARVEY, B.Sc., A.R.C.S., A.I.C.

Five candidates for admission to the Society will be balloted for.

INFORMAL DINNER.

Arrangements have been made for Members and their friends to dine together at St. James' Restaurant, 178, Piccadilly (opposite Burlington House), at 6.30 p.m. Tea and coffee will be served in the Library at 10 p.m.

Future meetings will be held on November 4, December 2 (1925); February 3, March 3, April 7 and May 5 (1926).

INSTITUTE OF METALS.

The Institute of Metals has just issued its programme for the session 1925-26, which begins in October. Six lectures on metallurgical subjects are to be given during the winter months before each of the Institute's local sections, which are centred respectively in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea. The programme also includes particulars of the meetings of the parent Institute in London. A copy of the programme can be obtained from the Secretary of the Institute of Metals (Mr. G. Shaw Scott, M.Sc.), 36-38, Victoria Street, London, S.W.1.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

22,640.- Binz, A. Production of 2 hydrazine-5-pyridine. September 10th.

22,355. Farbenfabriken vorm. F. Bayer & Co. Manufacture of pharmaceutical products, etc. September 7th.

22,738.- Gulf Refining Co. Process for removing aluminium chloride from vessels. September 11th.

22,360. Hunter, H.- Cover for metal containers holding deliquescent, etc. chemicals. September 8th.

Specifications Published this Week.

288,902. Mackay, H. S. Electrochemical treatment of copper ores.

288,956. Roessler & Hasslacher Chemical Co. Electrolytic process and apparatus.

239,060. Jackson Research Corporation. Process of drilling carbonaceous material.

231,168. Soc. Alsacienne de Produits Chimiques. Manufacture of borneols.

Abstract Published this Week.

237,528. - Formamide. Badische Anilin and Soda Fabrik, Ludwigshafen-on-Rhine, Germany.

Formamide is prepared by passing the vapour of ammonium formate or formic acid together with free ammonia, and with or without water, over a contact mass heated to a temperature between 100° and 200° C. The contact mass is preferably a dehydrating agent, *e.g.*, bauxite, and is heated to a high temperature before use. The formamide can be separated from the reaction gases by fractional cooling.

Messrs. Rayner and Co., will obtain printed copies of the Published Specifications only, and forward on post free for the price of 1/6 each.

The Latest TRADE MARKS

The following list of latest Trade Marks Published, is specially prepared for "*The Chemical News*," by Messrs. Rayner and Co., Regd. Patent and Trade Mark Agents, of 5, Chancery Lane, London, who will give all information free regarding the Registration of British and Foreign Trade Marks.

CRISALBINE.

461,294.- Double Thiosulphate of Gold and Sodium, being a chemical substance prepared for use in medicine and pharmacy. Les Etablissements Poulenc Freres, 86, Rue Vieille-du-Temple, Paris, France. September 9th, 1925.

ROCHE (and illustration of Tiger).

457,033. Chemical Substances prepared for use in medicine and pharmacy, but not including Saccharin or preparations, of mustard, or any goods of a like kind. The Hoffman-La Roche Chemical Works, Ltd., 7 and 8, Idol Lane, London, E.C. September 9th, 1925.

KHEPERIUM.

458,119. Salts, used for agricultural, horticultural, veterinary and sanitary purposes. Maude Dickinson, trading as M. Dickinson, Eastern House, 159, Marine Parade, Brighton. September 9th, 1925.

FLORAMA.

459,961. Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes, but not including fertilisers, or goods of a like kind. James Mitchell Whyte, 5 & 7, Ormeau Avenue, Belfast. September 16th, 1925.

DIARINE.

447,489. Medicinal powders (for internal human use). Dinah Bloom, 8, Preston Street, Glasgow. September 16th, 1925.

"DUX."

460,280. Chemical substances prepared for use in medicine and pharmacy.- Peter McCandlish Wilson, Woodbourne, North Hill Road, Leeds. September 16th, 1925.

TAR-E-GORIC.

460,649. Chemical substances prepared for use in medicine and pharmacy. - W. H. Cockton, 41, Talbot Road, Old Trafford, Manchester. September, 16th, 1925.

The above Marks have been "accepted" by H.M. Patent Office, and unless any objection is lodged, the Marks will be duly Registered They are, however, officially advertised for opposition, which must be lodged within one month from date quoted. All particulars and forms for opposition will be sent free by Messrs. Rayner and Co., 5, Chancery Lane, London.

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THE ELECTROLYTIC SEPARATION OF COPPER.

By ROBERT SAXON, B.Sc. (Vict.).

The electrolysis of an intimate mixture of calcium chloride, ammonium carbonate, and copper pyrites, gives an abundant deposit of ferric hydrate, and also of copper sulphide. Chlorine is given off, and ferric chloride deeply colours the solution. If the current be reversed repeatedly, clouds of copper sulphide are formed, and slowly decomposed by the current, copper being deposited. This is not recommended as a means of easily obtaining copper, but it easily separates the sulphide.

MALACHITE.

Rather more ammonium chloride than is necessary to convert the copper into cupric chloride is taken. Sufficient calcium hydrate is added to liberate the ammonia. It is intended that the following take place

$$Cu(OH)_2.CuCO_3 + 4NH_4Cl \text{ gives}$$
$$2CuCl_2 + 2NH_4OH + (NH_4)_2CO_3$$

The ammonia is liberated by the calcium hydrate and the solution rapidly turns blue from the solution of the compound $CuCl_2 4NH_3$, which is rapidly dissociated by the current, copper being deposited. Carbon dioxide is given off at the anode, and hydrogen at the cathode. Malachite or pure copper carbonate dissolves in ammonium hydrate, but neither of these does so in ammonium chloride, yet a mixture of malachite and ammonium chloride yields copper upon electrolysis. There is a faint blue colour round the cathode, due to the liberation of ammonia, and a yellow tinge round the anode due to chlorine. Solution is essential to electrolysis, and ammonia makes this possible.

BLUE VITRIOL.

A saturated solution of copper sulphate gives on electrolysis an abundant crop of spongy copper, *because of the impurity present*. Pure crystals do not respond at all readily. Any ordinary salt has a base that will displace copper, being more electrochemically negative. Hence an impurity metal carrying a stronger negative charge than the copper displaces that metal with the aid of the positive charge on the anode, and the weaker base is deposited. Thus may the action be represented—

$$Cu \text{ -X- } CuSO_4 \quad FeSO_4 \quad H_2O\text{—x—}0$$

new compounds being made within the dotted lines, copper being deposited at the cathode, always to the left, and oxygen at the anode, always to the right in this symbolic notation. The carbon anode is soon eaten away, and this is a defect of this process.

Another more efficient method consists in *adding ammonium chloride*. The region around the cathode becomes blue from the formation of the compound with the liberated ammonia, chlorine is liberated at the anode, the carbon is not therefore attacked, and the copper is deposited more rapidly as sulphanion has chlorion to displace instead of other sulphanion. There is hydrogen evolved as well as copper and ammonia at the cathode.

The addition of calcium hydrate results in the formation of calcium chloride and the sulphate, with the precipitation of copper hydrate. This, however, dissolves in the liberated ammonia and electrolysis proceeds rapidly, copper being deposited and chlorine being given off rapidly colouring the water quickly.

A fourth method consists in electrolysing a mixture of copper sulphate, ammonium chloride and sodium chloride in equimolar proportions. Advantage is taken of the stronger basic character of sodium over copper, and the stronger acid quality of sulphanion over chlorion. This method is

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

the best of these tried. The current flows easily and rapidly. Copper of very pure nature is thrown down round the cathode in plenty, and the carbon anode suffers very little disintegration. The action may be symbolised thus—

$$Cu—X—CuSO_4 \quad 2NH_4Cl \quad 2NaCl——Cl$$

As there is a distinct affinity for ammonia on the part of copper sulphate, it joins the sulphate at first to form the blue mono- to penta- ammonia compounds, which immediately decompose, giving fresh ammonia and dropping copper.

The anode throughout these experiments was of carbon pencil, the cathode (shewn as X) of steel, and the jar of glass carrying a glass partition, between the electrodes, perforated. Of course, the action would be quicker if copper anodes were used, but these would complicate matters from a research point of view.

DECOMPOSITION OF TRINITRO-TOLUENE BY THE ACTION OF SUNLIGHT.

By Professors C. Krauz and O. Turek.

(Continued from Last Week.)

(a) The Mixtures of TNT with Metallic Picrates.

For these tests we prepared finely spread mixtures of pure dry TNT with additions of 5, 10 and 20 per cent of pure dry picric acid and further in the same ratios the mixtures with quite dry metallic picrates.

The mixtures were always wrapped in envelopes of tin foil, as already mentioned, immediately after weighing. Before beginning the sensitiveness tests, they were always left 24 hours in a desiccator above concentrated sulphuric acid.

Addition	%	Kind of explosion	35	40	45	50	55	60	65	70	75	80	85	90	95
Trinitro-		none											4	3	1
toluene	- -	partly											2	3	5
alone		compl.											-		1
		n.						4	3	1					
	20	p.						2	2	3					
		c.							1	2					
Picric		n.							6	5	2				
	10	p.							-		3				
acid		c.							-	1	1				
		n.									4	2	- -		
	5	p.									2	2	3		
		c.										2	3		
		n.							5	3	1				
	20	p.							1	2	1				
Mercurous		c.							—	1	4				
		n.								4	4	1			
picrate	10	p.								2	1	2			
		c.								..	1	3			
dried at 100°		n.								3	1				
	5	p.								2	5	1			
		c.								1	- -	5			
		n.						4	4	2					
	20	p.						2	1	1					
Mercuric		c.						—	1	3					
		n.						4	3	2					
picrate	10	p.						2	3	2					
		c.						-	.	2					
dried at 130° C.		n.								2	—	1			

	5	p.								4	5	2			
		c.								—	1	3			
		n.	2	—	—										
	20	p.	4	5	4										
Lead		c.	—	1	2										
		n.			4	2	—								
picrate	10	p.			2	3	4								
		c.			—	2	2								
dried at 180° C.		n.						3	3	2					
	5	p.						3	1	1					
		c.						—	2	3					

From results mentioned in this table we see that the sensitiveness of the original TNT (95 cm.) rises with the added substances in a very considerable degree. Especially this fact is plainly distinguished if we express the results as a curve (see Diagram 1). The addition of picric acid alone to pure TNT leads to the curve (thickly drawn) in which is seen the increase in the sensitiveness of 15-30 cm., *i.e.*, about 16-32%. This curve practically falls in with the curves of additions of mercuric, ferric and calcium picrates point to further increasing of 5 cm. *i.e.*, totalling about 21-37% A more considerabe increase, *i.e.*, of 20-40 cm. (21-41%), shows the addition of the aluminium, zinc, sodium and potassium picrates. The addition of cupric, manganese and barium picrates acts still more. The greatest is lead picrate, which augments the sensitiveness by 42-63 per cent.

(b) The Mixtures of TNT with Trinitrobenzoates.

These experiments were conducted like the above.

Addition	%	Kind of explosion	35	40	45	50	55	60	65	70	75	80	85	90	95
						Fall in Centimetres.									
		none			2	2	--	—							
	20	partly			2	2	1	—							
Cupric		compl.		.	—	2	5	1							
		n.				5	2	3							
picrate	20	p.				1	3	—							
		c.				-	1	3							
dried at 180°		n.					2	2	—						
	5	p.					4	3	3						
		c.					—	1	3						
		n.					4	4	3						
	20	p.					—	1	1						
Nickel		c.					—	1	2						
		n.						5	4	3					
picrate	10	p.						1	1	1					
		c.						—	1	2					
dried at 180°		n.								4	3				
	5	p.								1	1				
		c.								—	2				
		n.						3	1	—					
	20	p.						3	3	2					
Ferric		c.						—	2	4					
		n.							—	1	—				
picrate	10	p.							6	3	1				
		c.							—	2	5				
dried at 180°		n.								3	1	—			
	5	p.								3	1	2			
		c.								—	4	4			

		n.					3	3	2						
	20	p.					1	1	2						
Aluminium		c.					2	2	2						
		n.								2	1				
picrate	10	p.								8	2				
		c.								1	8				
dried at 100°		n.									4	1			
	5	p.									1	4			
		c.									1	1			
		n.				4	8	8							
	20	p.				1	1	1							
Manganese		c.				1	2	2							
		n.				5	4	8							
picrate	10	p.				1	1	1							
		c.				—	1	2							
		n.						5	8	8					
	5	p.						1	2	—					
		c.						—	1	8					

Addition	%	Kind of explosion	Fall in Centimetres. 35	40	45	50	55	60	65	70	75	80	85	90	95
		none					8	1	—	8					
	20	partly					1	—	1	1					
Zinc		compl.					2	1	1	2					
		n.						6	6	2					
picrate	10	p.						—	—	1					
		c.						—	—	8					
dried at 180°		n.								5	4				
	5	p.								1	1				
		c.								—	1				
		n.						5	4	2					
	20	p.						2	1	2					
Magnesium		c.						—	1	2					
		n.							5	8	1				
picrate	10	p.							1	2	8				
		c.							—	1	2				
dried at 180°		n.								5	2	8			
	5	p.								—	2	2			
		c.								1	2	1			
		n.			8	—	—								
	20	p.			8	8	—								
Barium		c.			—	3	6								
		n.				5	2	2							
picrate	10	p.				—	8	2							
		c.				1	1	2							
dried at 180°		n.						4	8	—					
	5	p.						2	1	1					
		c.						—	2	5					
		n.				4	6	4							
	20	p.				—	—	1							
Calcium		c.				—	—	1							
		n.						8	8						
picrate	10	p.						2	1						
		c.						1	2						
dried at 180°		n.							4	8					
	5	p.							2	1					
		c.							—	2					

Addition	%	Kind of explosion	Fall in Centimetres. 35	40	45	50	55	60	65	70	75	80	85	90	95
Potassium picrate dried at 100°	20	none				5	3								
		partly				1	2								
		compl.				—	1								
	10	n.						4	2						
		p.						2	1						
		c.						—	3						
	5	n.								4	2				
		p.								2	3				
		c.								—	1				
Sodium picrate dried at 130°	20	n.				6	3								
		p.				—	1								
		c.				—	2								
	10	n.						6	4						
		p.						—	1						
		c.						—	1						
	5	n.								6	1				
		p.								—	3				
		c.								—	2				

Addition	%	Kind of explosion	Fall in Centimetres. 35	40	45	50	55	60	65	70	75	80	85	90	95
Trinitro toluene alone	—	none											4	3	1
		partly											2	3	5
		compl.											—	—	1
Trinitro-benzoic acid	20	n.							3	2	4				
		p.							2	3	1				
		c.							1	1	1				
	10	n.								4	-	1	3		
		p.								1	—	3	1		
		c.								1	-	2	2		
	5	n.										3	3	1	
		p.										2	2	—	
		c.										1	1	1	

Addition	%	Kind of explosion	Fall in Centimetres. 35	40	45	50	55	60	65	70	75	80	85	90	95
Mercurous trinitro benzoate dried in desiccator	20	none					4	3	1						
		partly					2	2	2						
		compl.					—	1	3						
	10	n.						3	3	—					
		p.						3	1	3					
		c.						—	2	3					
	5	n.							4	3	1				
		p.				...			2	2	3				
		c.							—	1	2				
Mercuric trinitro-benzoate	20	n.					5	3	3						
		p.					1	1	2						
		c.					--	2	3						
	10	n.							4	4	—				
		p.							1	1	1				
		c.							1	1	5				

dried in		n.						8	—
	5	p.						3	2
desiccator		c.						—	4
Lead		n.	5	8	4				
	20	p.	1	2	1				
trinitro-		c.	—	1	1				
		n.			4	4			
benzoate	10	p.			1	1			
		c.			1	1			
dried in		n.				4	5		
	5	p.				2	--		
desiccator		c.				—	1		
Cupric		n.		5	1				
	20	p.		1	2				
trinitro-		c.		—	8				
		n.			8	—			
benzoate	10	p.			2	—			
		c.			1	2			
dried in		n.					6	4	·
	5	p.					—	1	—
desiccator		c.					—	1	1
Nickel		n.			6	8			
	20	p.			—	1			
trinitro-		c.			—	2			
		n.					5	2	
benzoate	10	p.					—	3	
		c.					1	1	
dried in		n.						8	2
	5	p.						2	2
desiccator		c.						1	2

(To be Concluded Next Week.)

PEDESTAL ROCKS IN STREAM CHANNELS.

By Kirk Bryan.

(U.S.A. Geological Survey.)

Isolated masses of rock, especially those of unusual shapes, excite much interest and are commonly regarded with some little awe—a relic, perhaps, of those feelings and impulses which caused the erection of the great stones of the Druid monuments. The fanciful or mythical names that are almost spontaneously applied to such rocks testify to this popular interest, but the origin of these masses has received only scant notice by scientific men. This attitude is no doubt justifiable on the ground that there are more important matters for study. However, the type of isolated rock consisting of a larger mass above supported on a more slender pedestal has been used as a criterion in the study of larger problems. Such pedestal rocks have been cited as a measure of weathering since glaciation and also as proof that an area was not covered by continental ice. That pedestal rocks may be formed by the sand-blast action of winds seems probable, but that such rocks in arid regions are necessarily proof of wind scour has been denied in a previous publication, in which a fairly complete list of papers on the affirmative of this question may be found.

The object of this paper is to call attention to some examples of pedestal rocks of well-developed form that stand in stream channels and are produced by a process which bears no casual relation to wind erosion, yet that, if found in some other environment, might easily be confused with pedestal rocks resulting from wind scour.

Devil's Top and Similiar Rocks Near Spokane, Wash.

Spokane, Wash., lies at the eastern margin of the Columbia Plateau, which terminates here in black cliffs and crags of basalt that front on the broad valleys of Spokane and Little Spokane rivers. In these valleys stand outlying portions of the plateau bounded by similar cliffs. Spokane River within the city plunges over ledges of basalt in Spokane Falls and about 7 miles below the city enters the long canyon that forms the north-eastern boundary of the Columbia Plateau. The basalt flows that form the top of the plateau, known as the "rim rock" flows, have an altitude of about 2,400 feet. The flows that crop out in the bed of Spokane Rives and in the immediately adjacent cliffs, are a younger series that attain an altitude only slightly above 2,100 feet. They lie within ancient valleys eroded in the plateau. These valley flows, though younger than the flows of the plateau, are thought to belong to the same general period of volcanism, in Tertiary time. The lavas of this series, at least in the immediate vicinity of Spokane, do not have the columnar jointing normal to basalts but are divided into great blocks by widely spaced joints. In consequence, they yield on erosion large masses, many of which have peculiarly striking forms. Some of the most interesting of these masses are to be found in the canyon traversed by the lower course of Deep Creek, a stream that rises on the plateau and flows north-eastward about 15 miles to Spokane River, which it enters 8 miles below Spokane. The stream plunges over the "rim rock" basalt and has cut a deep and narrow gorge in the younger basalt flows, which form a shelf along Spokane River. The lower part of the canyon is at one place only about 50 feet wide, and here is the Devil's Top, one of a number of blocks that have fallen from the cliffs above. This block tapers from a rounded top to a narrow base. The rock would fall but for the fact that it rests against the side wall. It is nearly circular in plan and about 30 feet in greatest diameter. It is about 28 feet high and the tapering base is about 3 feet in diameter where it rests on the bedrock of the stream channel.

The rounded form of the upper part of the Devil's Top is a characteristic weathering form of the basalt of this locality, and similar rounded domes cap the cliffs from which this block has undoubtedly fallen. The minutely and irregularly fractured surface is also characteristic and may be ascribed with some assurance to frost action. Only in shape does the rock differ from adjacent blocks.

Rock in Owen's River, California.

The photograph was taken by Willard D. Johnson in the canyon of Owen's River, Inyo County, California. According to his notes the locality is "just above the junction of Burcham Canyon and 'The Bridge'"; the rock is rhyolite of the "exfoliating type" found thereabouts and contrasting with a neighbouring type which yields to weathering largely by solution. Johnson records also that the boulder is said to have developed the neck or pedestal in the twenty years that it had been under observation by ranchmen in the neighbourhood.

At this point, Owen's River runs in a deep canyon and is swift and turbulent. However, as shown by the records of the United States Geological Survey gauging station near Round Valley, just above the junction of Rock Creek, at the lower end of the canyon, the flow of the stream is relatively steady. The yearly mean discharge has ranged from 181 to 380 second-feet. The maximum recorded discharge of 1,190 second-feet occurred in June, 1907, and the minimum of 100 second-feet in February, 1919. Evidently the ordinary flow, fluctuating over a narrow range, has eroded the neck of the rock, and the flood flows are not severe enough to break it off.

The region has an arid climate and might even be called a desert. The river in the canyon descends from an altitude of 6,700 feet to 4,400 feet, and the climatic conditions are similar to those at the nearest towns, Bishop and Laws, which have an altitude of about 4,100 feet. The 16-year rainfall record at Bishop, as compiled by Lee, shows an annual mean of 5.61 inches, and the 14-year record at Laws, 4.40 inches. Even if allowance is made for an increased rainfall in the locality of the pedestal rock on account of its greater altitude, it may still be considered in an arid region.

Though the statement of the local ranchers recorded by Johnson that the shape of the rock was developed in twenty years can hardly be true, it is evident from the photograph that stream abrasion oper-

ating against the surface of a rock already divided into small flakes by exfoliation has produced the notch that forms the neck. The neck is eccentric, and the greater overhang on the upstream side may be due to which this block has undoubtedly fallen. greater wear on that side. The rock appears also to have been slightly polished by the water and its contained suspended matter.

The rocks described in the foregoing paragraphs are, so far as form alone is concerned, typical "mushroom" or pedestal rocks. They are composed of material of almost equal hardness from base to top, and have attained their form as the result of differential scour rather than differential weathering. Thus they differ in composition and origin from the pedestal rocks described in a previous publication.

Save for the fact that these rocks occur in stream beds, they might be mistaken for rocks formed by wind scour. It is also entirely possible that rocks in arid regions formed by stream scour may have been mistaken for rocks formed by wind scour. Such confusion is the more likely in that the areas in which the examples cited in this paper occur have no great similarity in climate. Eastern Washington, in which the Devil's Top and the rock in Columbia River were formed, has a sub-humid or semi-arid climate, typified by that of Spokane, which has a mean annual precipitation of 18.85 inches and a cold winter. The Owen's River canyon lies in a warm arid region with an annual rainfall of only a little more than 5 inches. Yellowstone Park, on the other hand, has a cold humid climate. The character of the stream flow and the original form, position, and physical characteristics of the rocks are probably more influential than climate in producing these remarkable forms.

NOTE.—The rock in Gibbon River, Yellowstone Park, has also been described by E. A. Martel, who visited the locality with the International Congress of Geographers in 1912. His note, illustrated with three excellent photographs, was published in the Comptes Rendus des Séances de l'Académie des Sciences de Paris, vol. 159, pp. 87-89, 1914. Martel has also described a large number of pedestal rocks in other localities, which he attributes to the action of both surface and underground streams.

General Notes.

LONDON COUNTY COUNCIL'S GREAT EDUCATION SCHEME.

Apart from its comprehensive elementary educational system, as exemplified in its elaborate chain of Board schools, throughout the Metropolis (and at which an excellent education is provided free of cost), the London County Council is also carrying on a great and beneficent work in the realm of higher education, including technical and electro-chemistry, chemical engineering, and many other branches of science and art, enabling the ambitious and assiduous student degrees and diplomas. Special attention is paid to chemistry, we - as the oldest chemical paper are pleased to note. Needless to say, the County Council's efforts are duly appreciated by the London University, The Institute of Chemistry, and most other learned societies.

Among the centres where higher instruction is given, are the Battersea Polytechnic, Battersea Park Road, S.W.11.; Borough Polytechnic, Borough Road, S.E.1.; Chelsea Polytechnic, Mauresa Road, Chelsea, S.W.8; City of London College, White Street, Moorfield, E.C.2; Hackney Institute, Dalston Lane, E.8.; Northampton Polytechnic, St. John Street, E.C.1; Northern Polytechnic, Holloway Road, N.7.; L.C.C. Norwood Technical Institute, Knight's Hill, S.E.27.; L.C.C. Paddington Technical Institute, Saltram Crescent ,W.9.; Regent Street Polytechnic, W.1.; Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3.; Wandsworth Technical Institute, High Street, Wandsworth, S.W.18.; Woolwich Polytechnic, William Street, Woolwich, S.E.18., etc. Not only are these centres of higher education established throughout the Metropolis, but the L.C.C. provides by its elaborate tram service, excellent facilities at very cheap rates for reaching the said centres. May its good work prosper.

BRITISH SCIENCE GUILD.

THE NORMAN LOCKYER LECTURE.

The first annual Norman Lockyer Lecture, established by the British Science Guild as a means of periodically directing the attention of the public to the influence of science upon human progress, will be gievn by Sir Oliver Lodge, F.R.S., on

Monday, 16 November, 195, at 4 p.m. The subject of the lecture will "The Link between Matter and Matter."

Lord Askwith, K.C.B., K.C., President of the Guild, will be in the chair, and the lecture will be held in the hall of the Goldsmiths' Company (by kind permission of the Master and Court of Assistants of the Company).

Tickets of admission may be obtained on application to the Secretary, British Science Guild, 5, John Street, Adelphi, London, W.C.2.

CANADIAN WATER RESOURCES.

The Dominion Water Power and Reclamation Service of the Interior of Canada has published a new volume of that portion of the series of water resources papers which deals with the surface water supply of Canada. This report is number 44 of the series, and gives details of stream measurements made in the provinces of Alberta, Saskatchewan, Manitoba and Western Ontario during the climatic year from October 1, 1922, to September 30, 1923.

It should be explained that the Dominion Water Power and Reclamation Service of the Department of the Interior is engaged in making a systematic survey of the water resources of the whole of the Dominion.

A separate series of stream measurement reports is published for each of these four divisions, and these cover respectively the Atlantic drainage south of St. Lawrence river, including Nova Scotia, New Brunswick, Prince Edward Island, and South-eastern Quebec; the St. Lawrence and Southern Hudson Bay drainage (and Mississippi drainage in Canada) in Alberta, Saskatchewan, Manitoba, extreme Western Ontario, and North-West Territorities; and the Pacific drainage in British Columbia and the Yukon Territory.

The report under review is one of the third series above described. It contains a short explanation of the purpose and scope of the work and two hundred and sixteen pages of tables and descriptions of gauging stations, with an index map of Alberta, Saskatchewan, Manitoba and Western Ontario showing their location. This report will be supplied free of charge on application to the High Commissioner for Canada, Canadian Building, Trafalgar Square, London, S.W.1., or to the Director, Water Power and Reclamation Service, Ottawa, Canada.

CANADIAN PRODUCTS IN 1924.

There was a slight advance in the production of talc and soapstone in Canada during 1924 according to the Dominion Bureau of Statistics. Sales for the year totalled 11,832 tons, worth $154,480, as against 10,366 tons, at $150,507 in 1923.

Increases in both quantity and value were recorded in finally revised statistics on the production of silver in Canada during 1924 as reported by the Dominion Bureau of Statistics. The output reached 19,736,323 fine ounces, valued at $13,180,113, as against 18,601,744 fine ounces valued at $12,067,509 in 1923.

The production of cheese in Canada in 1924 totalled 151,678,880 pounds, valued at $24,518,734 according to the Dominion Bureau of Statistics. Compared with the preceding year an increase of 49,504 pounds is shown in the quantity, but a decrease of over four million dollars in the value. The average price per pound was 16 cents in 1924 and 19 cents in 1923.

The output of zinc for the year 1924, as reported by the Dominion Bureau of Statistics was 98,909,077 pounds (49,455 tons) valued at $6,274,791, as against 60,416,240 pounds valued at $991,701. The increase amounted to 64 per cent. in quantity and 57 per cent. in value. This large increase was caused by the enlarged production in British Columbia. Quebec was the only other province to produce zinc; there an increase was reported of about two and a half million pounds.

Canada's exports during 1924 included 12,772 motor trucks, 48,888 passenger automobiles, and parts valued at $4,992,049, giving an aggregate value of $81,501,442, according to the Bureau of Statistics.

The quantity of creamery butter made in Canada in 1924 was 184,290,908 pounds valued at $68,449,160 according to the Dominion Bureau of Statistics. This production is the largest for any year in the history of the industry and exceeds the pro- The value of the production shows an increase over that of the preceding year of six million dollars, and almost equals the value for the record year of 1920, the greater value in that year being due to the high average price per pound—57 cents, compared with 34 cents in 1924.

THE ROYAL PHOTOGRAPHIC EXHIBITION.

Photographers in France have this year celebrated what they regard as the centenary of their art, since a hundred years ago, or thereabouts, their countryman, J. Nicéphore Niépce produced photographs by utilising the hardening action of light upon bitumen fixed to a metal plate.

The legitimate pride of the French, however, has perhaps obscured from their minds the earlier work (1802) of Thomas Wedgwood in conjuction with Sir Humphry Davy. (The essential steps in the historical progress of photography are given on pp. 131 *et. seq.* of my "Brief Outline of the History of Science," published by the *Chemical News*. An important article on *Photomicrography*, by E. H. Ellis, appeared recently in these columns.)

It is, therefore, of interest to note that the seventieth annual exhibition of the Royal Photographic Society is now in progress, and will remain open at 35, Russell Square, W.C., until October 24. Admission is free, and the illustrated catalogue costs 1s. The October issue of the Society's *Photographic Journal* (price 1s. 6d.) is a special exhibition number, and contains a review of the exhibits by well-known authorities, and is fully illustrated.

The photographs and exhibits are arranged in sections.

The first comprises the pictorial prints, which are on view in the main room of the first floor. Many show that progress has been made in technique, and some are of a high order of merit. The majority of the exhibitors are Members or Fellows of the Society, but a few are from distinguished foreign photographers, including one from Czecho-Slovakia.

Photographers now seem to find their most artistic and quaint settings on the continent, if the exhibition accurately reflects the actual trend of events. Perhaps, on the other hand, these may have been acquired whilst on holiday. The lantern slides also reflect the same tendency.

Among the many of merit, mention may be made of "Damascus Gate," by A. Keighley; "Andorra Vicella," by Bertram Park; "Re-conditioning the Victory" by Capt. E. J. Mowlam; "Noel Coward," by Miss Wilding; and "London," by A. G. Buckham. Many "cloudscapes" and sailing vessel photographs were also of high merit.

The pictorial lantern slides illustrated scenes in Spain, France, Italy, and a few of provincial England, etc. The scientific and technical slides are chiefly of natural history subjects, but a few illustrate the developments in photomicrography.

The Royal Aircraft establishment has contributed some good examples of aerial photography, and the International Western Electric Co., some photographs transmitted by telephone.

Demonstrations of Kinematography were given with the Pathé Baby Cine Camera; Messrs. Chance Bros. exhibited various types of optical glass as used for photographic lenses. Zinc crown glass represents the latest perfections in this work. Ross's also exhibited lenses, and Ilford's had an exhibit to illustrate the use of the panchromatic plate.

This exhibition constitutes an annual event of interest to all connected in any way with photography.

J. G. F. D.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section B. Chemistry.

THE CHEMISTRY OF SOLIDS.

Address by Professor Cecil H. Desch, D.Sc., Ph.D., F.R.S., President of the Section.

(*Continued From Last Week.*)

Of metallic alloys other than steel, the number of possible combinations is so large that only a minute fraction has been investigated. So far there is no rule by which we can mark out, in the neighbourhood of each metal in the periodic classification, a region within which useful alloying constituents may be found, but it is probable that further work will indicate such a possibility. The modification in the properties of a metal brought about by alloying depends largely on the formation of solid solutions, and when these vary in concentration with change of temperature, that is, when one or other constituent partly separates from solution on lowering, or sometimes on raising, the temperature, there is a possibility of changing the properties of the alloy by suitable thermal treatment. To a large extent this possibility has been neglected in respect of non-ferrous alloys, but experience with the light alloys

of aluminium has shown how important such effects may be. Duralumin, which is composed of aluminium alloyed with copper and magnesium, was first found to vary in mechanical properties when its thermal treatment was altered, and its behaviour, which is shared by some other alloys of aluminium, has been explained on the basis of observations made chiefly at the National Physical Laboratory and at the U.S. Bureau of Standards. It appears that certain of the constituents of these alloys, especially magnesium silicide, Mg_2Si, and the compound $CuAl_2$, are more soluble in the solid metal at high temperatures than at low, and that their state of aggregation in the cold alloy depends on the rate of cooling. When first separated from solution, these compounds are dispersed in a condition of ultramicroscopic fineness, but when sufficient time is allowed, diffusion enables them to form larger and larger particles, there being a certain degree of dispersion which is associated with the best mechanical properties. In light alloys, as in steel, the degree of dispersion of one of the solid phases throughout another plays a great part in determining the properties of the composite mass. In this respect alloys resemble colloidal systems, and analogies may be found between the two, but nothing is gained by representing metallography as a branch of the chemistry of colloids, and certainly nothing by the restatement of familiar metallographic facts in terms of the formidable nomenclature with which that important branch of chemistry has been saddled by some of its enthusiastic advocates. Metallographic structure is essentially a matter of the distribution of solid phases in a system, and the scale of subdivision of one of the phases, although of immense practical importance, is not a factor which alters the fundamental character of the relation between components and phases.

The theoretical part of metallography by means of which we interpret the thermal and microscopical observations of the laboratory is based on the doctrine of phases of Willard Gibbs. The purely thermo-dynamical treatment is, however, too abstract, and it is the simple temperature concentration diagram which is invariably used to represent equilibria in alloys, igneous rocks, or such artificial mixtures as cements. Only rarely is it necessary to appeal to the formal statement of the phase rule, most of the systems being simple enough for the number of possible phases at a given temperature to be obvious on inspection, whilst the vapour phase may usually be neglected. Systems of three components are represented by a three-dimensional model on a triangular base or by sections through the model, or by projections on to its base. For four components, the tetrahedral model is used, mainly in the form of sections, whilst for systems of greater complexity several devices have been proposed, but the study of alloys and mineral mixtures has scarcely progressed so far as to have made any serious demand for them. In time to come, both the metallurgist and the petrologist will need a means of representing such complex examples, but that stage will be reached by gradual steps. Allotropy of the dynamic kind represents difficulties, but it is not yet certain that the rather abstruse treatment adopted by Smits is necessary to its study, although evidence is accumulating that two allotropic forms may co-exist over a range of temperature within a solid, equilibrium only being attained with great difficulty. The metallurgist and the chemist interested in cements or other silicate mixtures has continually to bear in mind that he is dealing with systems which are not easily brought into equilibrium, and that for many practical purposes they are deliberately used in an unstable condition, persisting on account of the great resistance to movement within a solid, to which I have already referred. The equilbrium diagram serves as a guide, even to metastable systems, if the diagram be used to indicate the phases which may be expected to appear when undercooling occurs, and due use is made of the knowledge of undercooling which we owe to Miers and to Tammann. This is a most interesting branch of metallography, the theory of which is in course of development. Bowen, of the Geophysical Laboratory at Washington, has proposed another manner of studying the order of crystallisation in the liquid and solid states in mixtures of high viscosity, such as igneous rock magmas, and it is on the wonderful experimental work of that institution that the modern study of silicates on lines similar to those which have served so well in metallography is based. Bowen's reaction principle has to be reconciled with the theory of undercooling worked out for salts by Miers and for glassy materials by Tammann, and applied with success to steels by Hallimond. Meta-

stable or labile conditions may persist indefinitely when the viscosity of the system is great enough, hardened steels and prehistoric bronzes having undergone no perceptible change in structure in the course of centuries although Barus and others have shown that a secular change in the electrical resistance may be detected in steels, indicating a very small amount of reversion to the stable condition.

Chemical reactions in the midst of a solid may be prevented from reaching equilibrium by the formation of a layer of the solid product between two reacting substances. When a layer of this kind has been formed, further reaction is only possible by diffusion of atoms through it, and it will evidently depend on the closeness of packing of the molecules in that layer whether diffusion is easy or difficult. As a rule, it is probably more difficult than in the original solid, and we therefore find on microscopical examination that crystals of the two reacting sustances, whether pure metals, solid solutions, or intermetallic compounds are separated by a zone consisting of the product of reaction, which may be very persistent, although its breadth gradually diminishes on annealing. This effect is well seen, for instance, in alloys of copper with antimony.

An interesting class of reactions is that which includes the decomposition of a crystalline solid, one of the products escaping in the form of a gas whilst the other remains solid. From the nature of the curves connecting decomposition and time Huttig and others have concluded that the escaping molecules must be able to traverse the crystal freely without serious dislocation, but this view is not confirmed by examination by means of X-rays or in any other independent manner. On the other hand, Hinshelwood has examined a number of reactions in detail, giving special attention to the physical condition of the crystals before and after decomposition, and his experiments are not only of a higher order of accuracy but they include a study of the physical conditions of the reaction. The decomposition of the permanganates by heat has been found to be a convenient one for this purpose, since it procees at a moderate temperature, and the reaction is undoubtedly monomolecular. The initial rate of decomposition of silver and potassium permanganates is greatest when the solid is finely powdered, but when crystals of appreciable size are used, the decomposition proceeds at an accelerated rate, as the crystals become disintegrated. The results prove that the reaction is confined to the surface, and that it can only proceed inwards as the texture is loosened, so that diffusion does not play a part in the process, at least when the temperature is such that the decomposition is nearly complete in an hour or two. When solid solutions of potassium permanganate in potassium perchlorate are used, the latter salt being stable under the conditions of experiment, the rate of decomposition is lessened, the observed effect corresponding closely with that which is calculated from the heat of formation of the solid solution, a quantity which has been directly determined. Some similar decompositions are more complex owing to the catalytic effect of one or other of the products of reaction. The hindering effect of a solid coating, already referred to in connection with reactions in the interior of metallic alloys, is seen in the decomposition of ammonium dichromate by heat, large crystals becoming coated with an adherent layer of chromium oxide, which retards further decomposition.

Very recently Kurnakoff has studied the gradual change in the state of oxidation and hydration of vivianite, an hydrated ferrous phosphate. When first produced, these crystals are colourless, but they become blue as oxygen is absorbed, a part of the iron passing into the ferric state. Moreover the degree if hydration may vary as water is taken up from without. During these changes it is stated that the structure of the mineral remains unaltered and the crystals remain homogeneous, the optical properties varying continuously, but it does not appear from the abstract that any X-ray examination has been made. Such behaviour recalls that of the zeolites, the structure of which is probably loose. It is unlikely than any closely packed crystal could behave in this way.

A new field of investigation has been opened up by Tammann in his attempts to determine the arrangement of the atoms in solid solutions by purely chemical means, by studying the action of chemical reagents on the solid. It is a familiar fact that the 'parting' of silver and gold in assaying, which consists in dissolving out the silver from the alloy by means of nitric or sulphuric acid, is only possible when the silver forme more than 60 per cent. of the alloy. When gold is present in excess of this proportion, then only a little silver is removed from the surface, and the action then comes

to a standstill, the acid being unable to penetrate to the interior. Assuming the alloy to be completely crystalline, the atoms of silver and gold will occupy the points of the space lattice, and as the two metals have face-centred lattices of only slightly differing dimensions, the amount of distortion will be small. There are, however, different ways of arranging the two kinds of atoms. They may be distributed at random, or they may be so regularly arranged as to form two interpenetrating cubic lattices. The two forms of distribution may be distinguished by means of the X-rays, but Rammann has also drawn conclusions on the point from the action of various reagents on the alloys. He finds that each reagent which attacks silver ceases to act on the alloys when the proportion of gold atoms in solution exceed a certain limit, which is not the same for different reagents, but which he states to be always capable of being expressed at 1/8, 2/8, 3/8, etc., of the total number of atoms. The limits so found are not consistent with the distribution according to the laws of probability, but they may be accounted for by a regular distribution on the assumption that a certain number of inactive atoms is necessary to protect each atom of silver. The varying action of different reagents depends on the number of silver atoms which react with each molecule of the reagent. Thus, nitric acid attacks single atoms of silver, solutions of sulphides need two silver atoms, whilst osmium tetrachloride requires four. On the basis of these results, an ingenious theory of the action of reagents on solid solutions has been constructed, and although the accuracy of the experimentally determined limits is not high, and there are several exceptions to the rules, an interesting case has been made out. Similar limits are found in the precipitating action of alloys on salts of electropositive metals, and in the electrolytic potential of alloys.

Considerations of this kind point to the possibility of a new form of isomerism among solids, due to the differing arrangements of the same atoms on a space lattice. It is claimed that such instances have been found. Alloys prepared by the simultaneous electrolytic decomposition of two metals have different chemical properties, and different potentials from the alloys of the same composition prepared by fusion, the former indicating a random distribution of the two species of atoms in the lattice, and the latter an ordered one. Annealing of the first causes the structure to pass over into the stable, regular arrangement. Other properties may also be used as a test. Crystals of sodium chloride containing a small quantity (0.064 mol.) of silver chloride, when prepared from solution, readily become purple in light, whilst crystals of the same composition prepared by fusion are permanent for months. It is, however, quite possible that the former are not closely packed, and most of the facts cited by Tammann are capable of other explanations, but the hypothesis is highly suggestive in regard to the study of solid solutions by chemical means. In all such work it is important to remember that the size of the crystals, the possibility of the material having been cold worked previously to testing, and other physical and mechanical factors must be taken into account. The properties of single crystals in this connection are unknown, and the preparation of single crystals of solid solutions is much more difficult than that of pure metals, so that further work will be required before any definite opinion can be given as to the validity of Tammann's conclusions.

(To be Continued Next Week.)

NOTICES OF BOOKS.

Elementary Inorganic Chemistry, by F. W. Hodges, B.Sc., F.C.S. (Senior Science Master at the Coopers' Company's School, London), with diagrams. Price 8s. 6d. Longman's, Green and Co., 89, Paternoster Row, London.

The author has written a most useful work for pupils, as it contains just the information which they require, the matter being so arranged that the reader is introduced to the elementary principles of chemistry, and then led, step by step, to more advanced stages. Thus, Chapter I. deals with elements, atoms and chemical changes; Chapter II., composition of air and water; Chapter III., mixtures and compounds—the laws of chemical combination. A sample of the author's simple language and method is shewn in the paragraph on " The burning of a candle." " Fit a lamp-chimney, as shewn in Fig 2, with a piece of wire gauze and some sticks of caustic soda. [A clear diagram is given.] Cut some holes in a cork which fits into the chimney. On this place the candle, and weigh the whole thing. Now light the candle, and observe that as the burning goes on there is no decrease, but a gradual increase in weight. The candle consists of

carbon and hydrogen and, on burning, these combine with the oxygen of the air to form carbon dioxide and water, both of which are absorbed by the caustic soda. Here the system undergoing the change is the candle and the air surrounding it, and the loss of weight of the air will be exactly balanced by the increased weight of the apparatus." Simple experiments of this kind are calculated to excite the interest and curiosity of the pupil and induce him to become in his own way a votary of science. The chapters are followed by useful questions thereon, sometimes extending to pages, and there are numerous diagrams. The formulæ are such as a secondary school pupil can understand. It is a well-arranged, useful and cheap book which ought to have an extended sale.

An Introduction to the Physics and Chemistry of Colloids, by EMIL HATSCHEK. Fifth edition. 184 pp., with 22 illustrations. Price 7s. 6d. net. J. and A. Churchill, 7, Great Marlborough Street, London, W.1.

While the present edition is substantially that of the previous edition, it has been carefully revised by the author, and there has been included the important work of Porter and Hedges on the Vertical Distribution of Particles in Suspension, etc.. This addition does not materially alter the character of the work, which is deservedly popular, as attested by the number of editions already sold.

Laboratory Manual of Colloid Chemistry, Second Edition. 154 pp., and with 21 Illustrations. By EMIL HATSCHEK. Price 7s. 6d. net. Published by J. and A. Churchill, 7, Great Marlborough Street, London, W.1.

Multum in Parvo can truly be applied to this useful manual, as in its XXI. Chapters the author deals clearly with many phases of colloid chemistry. Thus, Chapter 1 is devoted to general remarks; 2, 3, 4 and 5, deal respectively with Dialysis, Suspensoid Sols, Suspensions and Non-Aqueous Suspensoids. Chapters 6, 7, 8, 9, 10, 11 and 12 are devoted to Oxide and Hydride Sols, Emulsoids Sols and Gels, Egg Albumin, Sol, Emulsions, Non-Aqueous Emulsoid Sols and Gels, Ultra-Filtration and Optical Methods of Examination. The following Chapters deal with Optical Methods of Examination, Cataphoresis, Electrolyte Precipitation of Suspensoid Sols, Mutual Precipitation of same, Protection, Viscosity Measurements, Adsorption (qualitative experiments), Capillary Analysis, The Concentration Function (adsorption), The Liesegang Phenomenon. There is given a name and also a subject matter index, and the work which is not encumbered with superfluous expositions, ought to prove useful in every way.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The eighty-seventh general meeting of the Royal Society of Arts, will take place on Tuesday, 13 October, 1925, at John Street, Adelphi, London, W.C.2.

The following paper will be read:

Notes on the Geology of Java, by ERNEST PARSONS, M.Sc., F.G.S., A.M.Inst.P.T.

The chair will be taken at 5.30 p.m. by the President, Sir Thomas H. Holland, K.C.S.I., K.C.I.E., F.R.S.

Dr. George Christopher Clayton, C.B.E., M.P., and Professor Henry Cort Harold Carpenter, F.R.S., have been appointed by Order of Council dated 16th September, 1925, to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

PATENTS RECENTLY FILED AT THE PATENT OFFICE, CANADA.

(CLAIMS ALLOWED.)

253,583. Method of making arsenical salts. (Fabrication de sels arsénicaux). Stewart Joseph Lloyd, University, and Absolom Mason Kennedy, Montgomery, co-inventors, both in Alabama, U.S.A., 15th September, 1925. Filed 24th November, 1924. Serial No. 297,185.

253,613. Dispensing Divice for Carbonated liquids. (Distributeur de liquides carbonés.) Max Dobrin, Cleveland, Ohio, U.S.A., 15th September, 1925. Filed 8 November, 1924. Serial No. 296,488.

253,600.- Spark arrester. (Pare-étincelles). William Herbert Buck, Norwood, Ontario, Canada. 15 September, 1925. Filed 7 January, 1925. Serial No. 289,429.

253,734. -Process of manufacturing Acetic anhydride. (Production d'anhydride acétique). The Consortium Fuer Elektrochemische Industrie,

assignee of Rudolf Meingast and Martin Mugdan, all of Munich, Bavaria, Germany. 15 September, 1925. Filed 23 February, 1925. Serial No. 209,952.

253,695. Electron discharge device. (Dispositif de décharge d'électrons). James Henry Thompson, Holliday's Cove, West Virginia, U.S.A. 15 September, 1925. Filed 9 February, 1925. Serial No. 209,467.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

23,350.- Denis, J. Process of treating waste liquors containing cyanogen compounds. September 18th.

23,116. Quick, A. S. Process for refining and decolourising oils and fats. September 16th.

22,892. Rupe, H. Manufacture of hydrocyclic-w-amino-alkyl compounds. September 14th.

Specifications Published this Week.

239,257. Smith, S. C. Conversion of lead sulphate into lead carbonate.

218,271. Suida, Dr. H. Manufacture of concentrated acetic acid from diluted acetic acid.

239,304. Bacon, W., and I. P. M. Syndicate, Ltd. Treatment of fibrous cellulose for the production of hydrated derivatives.

218,277. Terwilliger, C. O. Synthetic resins and process of making the same.

Abstract Published this Week.

237,702. Nitrogen peroxide. -- Soc. D-Etudes Minieres and Industrielles, II bis, Rue du Havre, Paris.

In preparing nitrogen peroxide by the interaction of ammonia and oxygen in presence of rhodium black, as described in Specification 183,041, the oxygen is replaced by air or oxygenated air, and the reaction mixture is passed over the catalyst at a rate which is less, about in accordance with the smaller oxygen concentration in the mixture, than the rate necessary when oxygen is used under conditions otherwise the same. For example, a mixture of 4 volumes of undried ammonia and 35 volumes of air are passed over the catalyst at one-fifth the rate necesary when 4 volumes of ammonia and 7 volumes of oxygen react under conditions otherwise the same. An example of the process is given.

Messrs. Rayner and Co., will obtain printed copies of the Published Specifications only, and forward on post free for the price of 1/6 each.

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

DECOMPOSITION OF TRINITRO-TOLUENE BY THE ACTION OF SUNLIGHT.

By PROFESSORS C. KRAUZ AND O. TUREK.

(Continued from Last Week.)

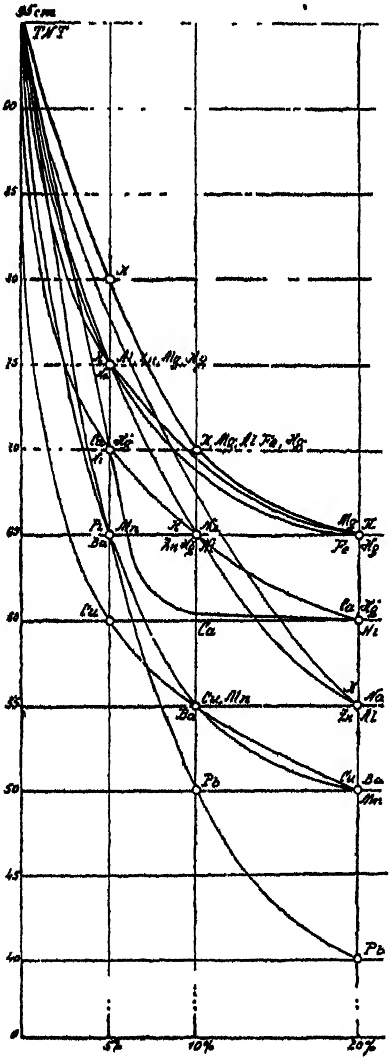
Addition	%	Kind of explosion	35	40	45	50	55	60	65	70	75	80	85	90	95
Ferric-	20	none				5	3	2							
		partly				—	2	2							
trinitro-		compl.				1	1	2							
	10	n.						2	8	—					
benzoate		p.						3	1	1					
		c.						4	2	5					
dried in	5	n.							3	2					
		p.							3	2	4				
desiccator		c.							—	2	2				
Aluminium	20	n.						6	4	3					
		p.						—	2	2					
trinitro-		c.						—	—	1					
	10	n.								2	2	2			
benzoate		p.								4	3	1			
		c.								—	1	8			
dried in	5	n.									8	1	1		
		p.									8	4	1		
desiccator		c.									—	1	4		
Manganese	20	n.				4		5	—						
		p.				2		—	2						
trinitro-		c.				—		1	8						
	10	n.						5	—	2					
benzoate		p.						1	—	1					
		c.						—	—	8					
dried in	5	n.							5	4	—	2			
		p.							1	1	—	2			
desiccator		c.							—	1	—	2			
Zinc	20	n.							—	1	—	2			
		p.							4	8					
trinitro-		c.							1	2					

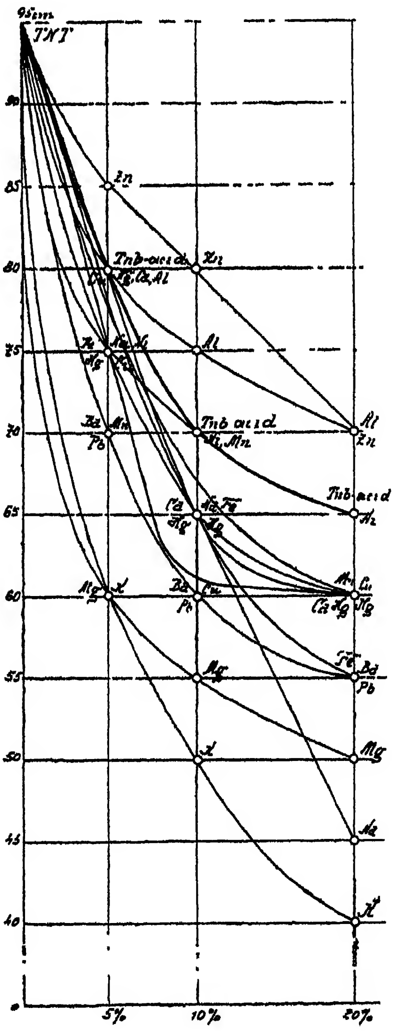
		n.								1					
benzoate	10	p.									5	2			
		c.									1	3			
dried in		n.									- -	1			
	5	p.									3	4			
desiccator		c.									3	1			
											—	1			
Magnesium		n.				3	1	2							
	20	p.				2	3	2							
trinitro-		c.				1	2	2							
		n.					3	2	1						
benzoate	10	p.					2	2	1						
		c.					1	2	4						
dried in		n.						3	3	-					
	5	p.						3	2	1					
desiccator		c.						--	1	5					

Addition	%	Kind of explosion	Fall in Centimetres. 35	40	45	50	55	60	65	70	75	80	85	90	95
Barium		none				5	3	4							
	20	partly				1	1	1							
trinitro-		compl.					2	1							
		n.						4	4	1					
benzoate	10	p.						1	2	2					
		c.						1	—	3					
dried in		n.							4	2	1				
	5	p.							2	1	3				
desiccator		c.							—	3	2				
Calcium		n.					4	8							
	20	p.					2	1							
trinitro-		c.						2							
		n.							4	8					
benzoate	10	p.							1	2					
		c.							1	1					
dried in		n.									3	—			
	5	p.									3	2			
desiccator		c.									—	4			
Potassium		n.	—	3	—	—									
	20	p.	1	2	6	—									
trinitro-		c.	—	1	—	2									
		n.			—	—	—	—							
benzoate	10	p.			6	4	—	4							
		c.			—	2	1	2							
dried in		n.					3	1							
	5	p.					8	2							
desiccator		c.					—	8							
Sodium		n.			4	3	8								
	20	p.			1	3	2								
trinitro-		c.			1	-	1								
		n.						4	2						
benzoate	10	p.						2	2						
		c.						-	2						
dried in		n.								5	8				
	5	p.								1	2				
desiccator		c.								--	1				

Similarly as at the TNT mixtures with picric acid, even here we see that the trinitrobenzoic acid and its salts can, by its presence, very remarkably rise the sensitiveness of TNT, which again is distinguished by corresponding curve (see Diagram II.) The addition of trinitrobenzoic acid alone corresponds in this case to the thick curve, TNB, which indicates the rising of the original (95 cm.) TNT sensitiveness of 15-30 cm, *i.e.*, about 16-32%. With this converges, practically, the curve of the nickel trinitrobenzoate mixture, while the curves of aluminium and zinc trinitrobenzoates lie remarkably higher, pointing to rising of the sensitiveness for mere of 10-25 cm., *i.e.*, about 11-26%. The most curves, *i.e.*, belonging to mercurous, mercuric, cupric, manganese, and calcium trinitrobenzoates, converge in the zone between the rising of 13-35 cm (*i.e.*, about 16-37%), while in the zone for the 20 to 40 cm. rising (about 21-45%), there are only three trinitrobenzoates, *viz.*, those of lead, iron and barium. The other increases always only correspond to one trinitrobenzoate: the magnesium salt which increases the original sensitiveness by 35-45 cm. (37-47%), trinitrobenzoate of sodium which causes a rising of 20-50 cm. (21-52%), and that of potassium which effects one of fully 35-55 cm. (37-56%).

The diagrams may be compared to show interesting relationships.





It is interesting to note that the curves of picric and trinitrobenzoic acids strictly overlap, thus the TNT sensitiveness is equally increased by the presence of both these acids. On the contrary, however, the behaviour of the salts of these acids under the same conditions is entirely different. While the curves for aluminium and zinc picrates are limited by a rising of 20-40 cm. the curves of trinitrobenzoates of the same metals diverge entirely from the zone of the trinitrobenzoic acid alone and raise the sensitiveness by only 10-25 cm. The picrates show the most intensive effects in the form the salts of lead, copper, manganese and barium, while on the other diagram these places are occupied by trinitrobenzoates of potassium, sodium and magnesium.

The difference in action of metallic picrates and trinitrobenzoates on pure TNT is best compared when both series are placed in line from the highest to the lowest sensitiveness.

The picrates, Pb, Cu, Mn, K. Na, Zn, Al, Ca, Hg., Ni, $Fe^{\cdot\cdot\cdot}$, $Hg^{\cdot\cdot}$, and picric acid alone.

The trinitrobenzoates, K, Na, Mg, Pb, Ba, $Fe^{\cdot\cdot\cdot}$, Cu, $Hg^{\cdot}$, $Hg^{\cdot\cdot}$, Ca, Mn, Ni, trinitrobenzoic acid alone, Al, Zn.

SUN EXPOSED TRINITROTOLUENE.

To prove by sensitiveness tests on the artificially prepared mixtures that the picric acid and also trinitrobenzoic acid and their metallic salts, can raise the TNT sensitiveness, we tried to test the sensitiveness to shock under the same conditions on the illuminated TNT, partly without additions and partly with additions of metallic copper, mercury and its oxides. The results are given below:--

	Kind of explosion	Fall in Cm. 60	65	70	75	80	85	90	95
The purest TNT	none						4	3	1
	partly						2	3	5
	compl.						-	—	1
TNT exposed to sun	n.			3	2	2			
	p.			8	3	2			
	c.				1	2			
Ditto, with addition of 5 p.c. of molecular copper	n.		4			1			
	p.		2	3		1			
	c.		—	1		4			
Ditto, with addition of 5 p.c. of metallic mercury	n.			—	1	1			
	p.			1	4	4			
	c.			1	1	1			
Ditto, with addition of 5 p.c. CuO	n.		4	1		--			
	p.		2	4		1			
	c.		—	1		5			
Ditto, with addition of 5 p.c. HgO	n.		4	2					
	p.		1	3		1			
	c.		1	1		5			

From the above mentioned results it is evident that the TNT illuminated by the sun's rays shows, compared with entirely pure TNT, a remarkable rise in sensitiveness to shock, *i.e.*, of at least 20 cm. or more than 22%. This increase would correspond according to the Diagram I. to the sensitiveness of TNT with an addition of about 7.5% of picric acid, or according to the Diagram II., about 7.5% of trinitrobenzoic acid. As it was possible to suppose from the experiments made, the sensitiveness of the illuminated TNT grows still further by the addition of metals ,and their oxides. The addition of 5% of copper or mercury causes a rising of sensitiveness of about a further 5%, while an addition of 5% mercuric oxide even up to 10%.

In concluding this memoir, which forms only a part of the results of our still incomplete experiments with TNT, we are inclined to the view that TNT is in no respect a substance so safe as was generally supposed.

Our experiments certainly prove plainly that in work with TNT it is advisable to avoid sunlight, which is able to cause changes in it of considerable magnitude, namely, the origin of picric and trinitrobenzoic acids. As the salts of these two acids especially can augment the sensitiveness of TNT, it is necessary to avoid every contact with metals and their oxides quite as much as, for instance, in work with picric acid.

SUMMARY.

The influence of sunlight on 2, 4, 6-trinitrotoluene reveals a definite oxidising reaction, because in the photoreaction, in addition to other products, the presence of picric and trinitrobenzoic acids was positively proved.

2. The picric and the trinitrobenzoic acid and also their salts increase considerably the TNT sensitiveness.

3. With the action of sunlight on TNT increases its sensitiveness which in an augmented degree passes to the values found in presence of metals or their oxides.

4. The TNT cannot, therefore, be considered as a safe explosive as was supposed up to this time.

5. In work with TNT it is necessary to avoid sunlight even as much as any contact of TNT with metals and their oxides.

Institute of Explosives,
Technical University of Prague,
Czechoslovakia.

1 *J. Ind. Engin. Chem*, X., 1028.

2 *Proc. Roy. Irish Acad.* XXXIVB., 175-193.

3 Tarry matter of α-Trinitrotoluene Boulogne-sur-Mer, 1922.

4 *Ann. Rep. Insp. Expl*, XXVIII., 26, 1903

5 *Chem. News*, CXII., 283, 1915.

6 *Atti. rend. Acad. Linc.*, 5, XXIII., II., 184, 1914, and *Gazz. chim. ital.*, XLV., I., 345, a. 352, 1915.

7 *Ber.*, XLVII., 707, 1914.

8 *Ztschr. f. d. ges. Schiess-u. Sprengwesen*, X., 28, 1915.

9 *Jahrber. d. Mil. Vers. Amts.*, XII., 17, 1907.

10 *Ztschr. f. d. ges. Schiess-un. Sprengwesen*, VI., 301, 1911.

11 *Studies in Actinochemistry, G. Washington Univ. J. Franklin Inst.*, CLXXX., 848, 1917.

12 *Ann. Chim. Appl.* XI., 186, 1912.

13 *C. r.* CXIX., 560; *A. Ch.*, 7, VIII., 131.

14 *Ztschr. f. d. ges. Schies-u Sprengstoffwesen*, MDCCCCXI., 34.

THE FORMULA OF CERIUM HYDRIDE.

By EDWARD JOSEPH WEEKS, Ph.D., M.Sc., A.I.C.

The object of this paper is to decide the formula of cerium hydride, which is at the present time very doubtful. Cerium hydride was discovered by Winkler, who obtained it by heating ceria to a red heat with magnesium in hydrogen. He ascribed to it the formula CeH_4 and described it as a brownish-red solid. Muthmann and Kraft (*Annalen*, 1902, CCCXXV., 261), prepared the hydride by heating the metal cerium in hydrogen from 220° to 270°, and obtained solids which were variously described as blue, red, or black. They could not obtain very definite analyses of the compound, but found the amount of hydrogen present to be 2.4% approximately. If the hydride is CeH_3, 2.09% of hydrogen is required, and if it is CeH_4, 2.79% of hydrogen is needed. They made the assumption that its formula was CeH_3, since it gave cerous salts with acids. Since, however, it occurs in the same group as carbon and silicon, both of which form definite hydrides of the type XH_4, its formula might just as well be CeH_4.

On heating in the air, cerium hydride gives both the oxide CeO_2 and the nitride CeN, and it has been assumed that the hydrogen was directly replaced by oxygen and nitrogen. This supposition appears to be very doubtful.

In the next group of the periodic system the hydrides of general formula XH_3 and X_2H_2 have been prepared. We hence have a possibility of the formation of a hydride of cerium, $H - Ce \equiv Ce - H$, which would require 0.6% of hydrogen. If this compound were formed as well as CeH_4 in the reduction of cerium, then a mixture containing 21% of Ce_2H_2 and 79% of CeH_4 would give 2.4% of hydrogen, *i.e.*, the percentage found by Muthmann and Kraft.

Now metallic hydrides of the type X_2H_2 decompose on heating according to the equation

$$3X_2H_2 = 2XH_3 + 4X$$

and hence if Ce_2H_2 were formed it would most likely decompose as below

$$2Ce_2H_2 = CeH_4 + 3Ce.$$

The cerium would then burn in the air, and since it is well-known that cerium in this respect exactly resembles magnesium in giving the oxide and the nitride an ex-

planation is reached as to the apparent direct replacement of hydrogen by oxygen and nitrogen. At a higher temperature the CeH_4 would decompose directly into hydrogen and cerium. The fact that the hydride forms cerous salts with acids proves nothing, since hydrogen is given off by the reaction and this would at once reduce any ceric salt formed. In the formation of cerium hydride, it appears, therefore, that probably a mixture of the hydrides CeH_4 and Ce_2H_2 is formed. This explains at once the difficulty of accurate analytical results and the varying colours of the substance.

This is further borne out by the fact that Muthmann and Baur (*Annalen*, 1902, CCCXXV., 281), have found that the dissociation pressure of the hydride is not constant, and they suggested that the hydride undergoes a slow peculiar change of molecular structure. This is not known in any other case, but on the assumption of the formation of two hydrides the result is easily explicable.

In conclusion, it appears that the so-called cerous hydride, CeH_3, is in reality a mixture of ceric hydride, CeH_4, and some lower hydride of probable formula, Ce_2H_2. Further experimental work is now being conducted to test this assumption.

The Battersea Grammar School,
St. John's Hill.
30/9/25.

UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR LOW-PRESSURE SPIRAL GLAND PACKING.

U.S.A. Bureau of Standards.

1. The fabric shall weigh not less than 27.4 ounces per square yard.

2. There shall be not less than one layer of frictioned fabric for each 1/16 inch of thickness, exclusive of the top and bottom covers.

3. The top and the bottom rubber cover shall each be not more than 3/64 inch in thickness measured to the bottom of the fabric impressions.

4. The top and bottom rubber cover shall contain not less than 45 per cent. by weight of the best quality new wild or plantation urbber. The acetone extract corrected for free sulphur shall not exceed 6 per cent., nor shall the total sulphur, exclusive of that contained in barytes, exceed 8 per cent. by weight of the rubber as compounded.

5. After being cut from the slab, the packing shall be coiled into spirals and vulcanised.

6. The inside diameter of the spiral shall be not less than four times nor more than six times the thickness of the finished packing.

7. The spirals shall be lubricated with mineral oil and dipped in graphite. The amount of lubrication shall not exceed 30 per cent. by weight of the finished packing.

8. There shall be neither ply separation nor material hardening of the rubber when a piece of finished packing is subjected to four hours' exposure to steam at 50 lbs. per square inch pressure.

9. The packing shall bend readily around rods as shown below :-

1/4 to 3/4	Equal to thickness of packing.
7/8 to 1 1/8	Equal to twice the thickness of packing.
Greater than 1 1/8	Equal to three times the thickness of packing.

10. The friction between the plies shall be such that a weight of 8 pounds per inch of width shall not cause the plies to separate at a greater rate than 1 inch per minute.

The packing shall weigh within 5 per cent. plus or minus of the proposed weights as submitted with the bids.

Method of Ispection.

The inspector shall select one sample 24 inches long for sizes up to 1/2 inch and 12 inches long for sizes over 1/2 inch, from each lot of 1,000 pounds or less.

Marking and Packing.

Material shall be marked and packed as called for in the proposal.

General Specifications.

All tests and analyses shall be made in accordance with the methods described in United States Government General Specifications for Rubber Goods, F. S. B., Specification No. 59a, in effect on date of proposal.

General Notes.

CANADA'S MINERAL INDUSTRY, PAST AND PRESENT.

The High Commissioner for Canada in London has received from the Mines Branch of the Dominion Department of Mines at Ottawa the following article entitled, "Canada's Mineral Industry, Past and Future."

The last quarter of a century has been a period of phenomenal growth in the mineral industry of Canada and in the entire industrial activity of the country. The twentieth century has been called Canada's century, and rightly so, if the enormous strides taken during the first twenty-five years may be taken as indicative of future progress.

Now that the disturbances produced by the great world upheaval of 1914-1918 are subsiding and as stable conditions are being attained, it might not be inopportune to take a very brief retrospective view of the mineral industry and note its growth. The following table gives the value of the mineral production for every fifth year from 1890 to date. For purposes of comparison and of giving a rough indication of general industrial activity, a column is added showing the external trade of the country, i.e., the total value of imports for home consumption and exports of merchandise.

Mineral Production.

Year		
1890	\$16,763,353	£3,444,525
1895	\$20,505,917	£4,213,545
1900	\$64,420,877	£13,237,167
1905	\$69,078,999	£14,194,315
1910	\$106,823,623	£21,950,060
1915	\$137,109,171	£28,173,117
1920	\$227,859,665	£46,820,479
·1924	\$209,516,465	£43,051,328

Aggregate External Trade.

Year		
1890	\$205,991,940	£42,327,111
1895	\$209,989,375	£43,148,501
1900	\$355,889,231	£73,127,924
1905	\$453,486,275	£93,171,837
1910	\$669,082,192	£137,482,642
1915	\$917,398,417	£188,506,524
1920	\$2,351,186,332	£483,120,582
1924	\$1,951,920,164	£401,079,486

ABOLITION OF GERMAN IMPORT LICENCES.

The Board of Trade announce that as from October 1 the requirement of import licences is withdrawn for all commercial goods imported into Germany except a small number, of which a list is published in the Board of Trade *Journal.*

CAIRO AGRICULTURAL AND INDUSTRIAL EXHIBITION.

Information has been received from the Egyptian Chargé d'Affaires in London to the effect that the Exhibition will open on 20 February, 1926, and continue until 20 March, instead of closing on 6 March, as previously stated.

Intending exhibitors should make application before 1 December, 1925, to the Royal Agricultural Society P.O.B. No. 63, Cairo. A copy of the regulations may be obtained on application to the Department of Overseas Trade (Exhibitions and Fairs Division), 35, Old Queen Street, London, S.W.1.

SWEDISH GENERAL ELECTRIC, LTD., ASSOCIATED WITH FULLER ELECTRICAL AND MANUFACTURING CO.

This company, whose works are at Walthamstow, and offices at 5, Chancery Lane, London, W.C.2., sends out a useful stock list (No. 116), which gives full particulars of the direct current and alternating current motors and dynamos which the firm regularly stocks in London. Pamphlet No. 102 is also to hand. It is handsomely illustrated, and gives descriptions of the various motors, rolling machines, etc.

IMPERFECTIONS IN LEATHER CAUSED BY MICRO-ORGANISMS.

By John Arthur Wilson and Guido Daub.

A. F. Gallun & Sons Co., Milwaukee, Wis. (*Journal of the Society of Leather Trades' Chemists*, 1925, p. 355.)

Considering how much damage is being done to skins and leathers by micro-organisms, surprisingly little effort has been made to determine the exact nature of such damage by means of the microscope. In fact, the literature contains very few photomicrographs showing damages to leather. It has been the writers' privilege to prepare and to study several thousands

of microscopic slides of skin and leather, a number of which show imperfections caused by micro-organisms. Of these they have selected a few showing the most common types of damage for presentation in this paper.

Most cases of damage occur before the skin has been tanned, although the damage itself may not be apparent until after tanning. Skins which have been improperly cured, stored in a warm place, or left in contact with warm or dirty water are usually attacked by bacteria. The conditions which determine the nature of the damage are, however, not well understood. There seems to be a special type of damage peculiar to each set of conditions. For example, in some cases only the grain surface seems to be affected, in others only the regions close to the blood vessels, and in others only the glandular region separating the thermostat and reticular layers of the skin.

The spots could not be seen at any stage during the conversion of the skin into leather until after the tanned skin had been dried, and they became most pronounced after finishing and glazing. An exhaustive study, in which microscopic slides of skin and leather were made and studied, revealed that the spots resulted from attack of the lining of the hair follicles in the raw skin by bacteria. The tiny fibres lining the follicles had been severed and partially destroyed. In the later treatments the cavities formed became clogged with dirt and with excessive amounts of finishing materials, with the result that the leather appeared spotted after finishing, greatly lessening its market value.

A peculiar thing about this damage is that the skin appeared not to have suffered damage anywhere except in the vicinity of the hair follicles. A similar type of spots has been found in other cases, however, in which the hair follicles were unattacked, while the fibres of the grain surface were severed over numerous isolated areas.

The spots appear very prominent after finishing and glazing because of the dark the appearance of the pattern of the blood damage was traced to bacterial action in the raw skin.

A very troublesome defect in leather is lustre they assume. Here, again, the vessel system on the surface usually referred to as veins. It becomes noticeable after the leather is dried and finished.

IMPORTANT ORDER FOR LOPULCO PULVERISED FUEL PLANT.

It is interesting to record that the Lopulco Pulverised Fuel System, the rights of which belong to International Combustion, Limited., of London, is to be installed in a new boiler of the Berlin Electric Light Works on 12 large boilers.

This order has been secured in face of the most exacting investigations by the German engineers into all known continental and American systems of pulverised fuel.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

Applications for Licences in September, 1925.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during September, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 570, of which 485 were from merchants or importers. To these should be added 24 cases outstanding on the 31st August, making a total for the month of 594. These were dealt with as follows:

Granted 405 (of which 379 were dealt with within 7 days of receipt).

Referred to British makers of similar products 121 (of which 93 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—23 (all dealt with within 2 days of receipt).

Outstanding on 30th September, 1925 · 45.

Of the total of 594 applications received, 495, or 83 per cent., were dealt with within 7 days of receipt.

CHEMISTS AND SUGAR BEET FACTORIES.

A report has been issued by the British Sugar Beet Society, Ltd., in which is outlined a scheme for training specialists for employment in the various factories. Among other things, the report says:

" The technical posts offered in a beet-sugar factory are comparatively limited. For (say) 50 factories the number of posts will be 400 to 450, including ' campaign ' chemists. These officers are in various

degrees responsible for the manufacture of beet sugar of a quality which will command the highest possible price, and in doing so, to work the factory on the most economic lines. This requires a course of training in general science and in sugar technology at a university or similar institution, supplemented by practical experience in a beet-sugar factory for several years. As the nature and quality of the raw material has a direct bearing upon beet-sugar manufacture, they will require a general knowledge of the principles of manufacture in their relation to sugar-beet cultivation. During the 'campaign' or manufacturing season from October to January they are entirely off-season, with the exception of the 'campaign' chemists, they study, and co-operate in the general direction of alterations, additions, etc., and the general overhauling of the plant."

NINE MONTHS' CAPITAL ISSUES.

New capital issues in Great Britain in the first nine months of the year totalled nearly 145 millions, as compared with £189 millions, £150 millions and £193 millions respectively in the corresponding period of the three preceding years.

NEW TURKISH SCIENTIFIC PUBLICATION.

The British Commercial Secretary at Constantinople has informed the Department that a new Turkish scientific magazine, entitled "Turkish Science and Industry," will shortly be published in Constantinople.

PITMAN'S JOURNAL OF COMMERCIAL EDUCATION.

AN INTERESTING JOURNALISTIC DEVELOPMENT.

Founded by the inventor of Pitman's shorthand in 1842, *Pitman's Journal*, at first entitled *The Phonetic Journal*, is about to become *Pitman's Journal of Commercial Education*. Its aim will be to deal with all aspects of commercial education, and it will be the only weekly periodical of its kind published in this country. The change, involving an enlargement from 32 to 48 pages was made with the issue of 8 October, which included special articles by leading authorities on all the subjects of commercial, secretarial and professional courses. This interesting journalistic development is a reminder of the increasing importance of commercial education as an integral part of the educational system of the country.

SPECIALISTS AND LIBRARIES.

The idea of providing an opportunity of intercourse between those engaged in assembling and distributing information in the fields of science, industry and public affairs, has met with an astonisring succes, under the auspices of the Association of Special Libraries and Information Bureaux (A.S.L.I.B.).

Sir Arthur Steel-Maitland, Bt., Minister of Labour, opened a conference at Balliol College, Oxford, which lasted from September 25 to 28, and was attended by over 200 delegates of organisations ranging from the scientific societies and large libraries, to research institutes and smaller associations of experts, in the aggregate probably representing more than half a million intellectual workers.

The attendance included M. Otlet, of the Institut International de Bibliographie, Holland, and the United States, and the international aspect of the subject was further emphasised by a valuable address from Professor Gilbert Murray, on the work of the Committee of Intellectual Co-operation of the League of Nations.

Dr. Chalmers Mitchell, F.R.S., spoke of the "World List of Scientific Periodicals," which has just been published with the help of the British Museum authorities, and which discloses the existence of some 25,000 separate journals, and for the first time gives a picture of the situation, which is truly staggering. Organisation, co-operation and the initiation of methods of exchange, are obviously desiable to keep the community in touch with world sources of information of such gigantic dimensions. The problems of translation and collective abstracting were dealt with in papers by several of the leading authorities in the engineering and chemical sciences.

The information sections of such Government departments as the Board of Education, Ministry of Health and Imperial Institute, were described, and certainly widened the knowledge of most of those present as to sources available in this direction. Mention was made of the encouragement given by Sir A. Steel Maitland, when in charge of the Department of Overseas Trade, to improving the availability of commercial intelligence.

Sir Horace Plunkett described the Co-operative Reference Library, which it is hoped to transfer from Dublin to London, and which should prove of value in the attempt to develop our agricultural life.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section B.—Chemistry.

THE CHEMISTRY OF SOLIDS.

ADDRESS BY PROFESSOR CECIL H. DESCH, D.Sc., Ph.D., F.R.S., President of the Section.

(Continued From Last Week.)

As a consequence of the early studies of crystals by means of X-rays, some metallurgists were at first disposed to accept the conclusion that the chemical molecule ceased to exist in the solid state. This generalisation, which was instinctively felt by chemists to be improbable, was premature. Crystals of elements are clearly so constructed that all atoms are similarly related to one another, and there is then no group intermediate between the atom and the whole crystal, whilst crystalline salts are best regarded as built up of ions, every chlorine atom in rock salt being equally related to six sodium atoms and so forth, but these conditions do not exhaust the pos-silicates. Organic compounds undoubtedly retain the chemical molecule, or some simple multiple of it, in the solid state, and the same is true of the very interesting class of compounds which metals form with one another. These are of a non-polar character, and hence have long puzzled chemists on account of their utter disregard of valency. Such a compound as $NaHg_2$ melts at 360°, or more than 200° above its less fusible component, and is largely undissociated in the molten condition. It evidently represents a very stable union of the sodium and mercury atoms, and it has many analogues. The intermetallic compounds have several features of interest. Their space lattice arrangement has been studied in a number of instances, but the correlation of their chemical properties with their atomic and crystalline structure still remains to be undertaken.

If our knowledge of the chemical properties of the interior of a crystal be very incomplete, what are we to say of its surface? Of this we know still less. Even in a crystal of a pure metal there must be some difference in the structure at the immediate surfact, on account of the unsymmetrical forces between the atoms in the outermost layer and its neighbours. For so far as the radius of sensible atomic forces extends, therefore, there must be a condition different from that which prevails at a depth below the surface. One consequence is that the surface has residual affinity, which shows itself in the ease with which foreign atoms or ions will attach themselves to it. That the forces acting are chemical is shown by the great effect on the extent of adsorption of the chemical character of the solid and of the adsorbed surface. Films, often one atom thick, attach themselves to the solid, and are only removed with the greatest difficulty. Their presence makes the investigation of the properties of a surface difficult, as the surface actualy examined may be in reality quite different from that which is assumed to be present. In photochemical experiments with mercury it is usual to prepare a completely fresh surface of the liquid metal by causing it to flow continuously in a fountain, but this device cannot be applied to solids. Only rarely can experiments be made with perfectly defined solid surfaces. Films of metal prepared by sublimation or sputtering an a vacuum are probably the most under control, but other surfaces are commonly covered by invisible films. Little trust is to be put in determinations of the angle of contact of liquids with solids, a property of great theoretical and practical importance, since the solid surface actually examined is covered with a film of foreign atoms. Schumacher has recently shown that mercury wets glass and silica more and more readily as care is taken to remove films from them, and the property of not being wetted by mercury is probably not one of glass and silica, but of those substances coated with a film of gas. Metals most readily take up atoms of oxygen or other elements, forming persistent films, which play an important part in the phenomena of resistance to corrosion. Purely physical theories of passivity are not satisfactory, and it seems to be impossible to explain that property without assuming the presence on the surface of an invisible film, which is probably responsible for, among other things, the high resistance of certain chromium steels and other alloys to corrosion.

There is one way of preparing a fresh surface of a crystalline solid for examination, and that is by cleavage. A freshly cleaved plate of a mineral may be supposed to be clean at the moment of its formation, although it will rapidly take up foreign atoms from the surrounding gas. It was known as far back at 1846 that a fresh

cleavage of mica had different properties from one which had been exposed to the air for a time, and this was attributed by P. Reiss to the absorption of moisture. Tammann has made the interesting observation that a fresh surface of mica is more soluble in water than an older one. Washing with water immediately after cleaving extracts a quantity of alkali salts which is much above the normal solubility of mica, and later washings extract only the normal quantity. It is suggested that the separation of the flakes of mica exposes the alkaline part of the molecules, which would be more readily attacked by water than the silicious part. Assuming that molecules are arranged perpendicularly to the cleavage planes, we may think of the act of cleaving as exposing the soluble ends, as if the molecules of mica were an array of hermit crabs with their soft unprotected ends exposed to attack. It will be interesting to see whether the X-ray examination of mica confirms this arrangement. Again, however, a word of warning as to the effect of possible impurities must be uttered. Natural minerals are not pure, and any uncombines alkaline salts present might well segregate along cleavage planes in the process of crystallisation, and so give rise to the effect noticed above, but the figures recorded by Tammann are striking and suggestive.

In this hurried review of a large field it may seem that I have presented rather our ignorance than our knowledge, my intention having been to show how much remains to be done before we can understand the chemical relations of solids as we do those of liquids and gases. One department of research is, however, more advanced than might have been supposed from my brief references to it. That is the study of the internal changes in metallic alloys as revealed by the microscope and by thermal and electrical methods. Metallography has made wonderful progress since the days of Sorby, and it would repay students of physical chemistry to give some attention to its main results, even though they may not intend to make a special study of the subject. Nowhere are the benefits of the doctrine of phases of Willard Gibbs to be more clearly traced, whilst the recognition of every change of phase by microscopical examination, making use of a technique which has been brought to a high state of perfection gives concrete reality to the study by direct verification of its conclusions. To understand more thoroughly the mechanism of these changes in alloys and to extend its application to salts, minerals, and rocks, we need a fuller knowledge of the relation between crystal structure and chemical behaviour. Research on the mechanical side is covering the direction of planes of slip in the atomic space lattice under stress, and it remains to determine the corresponding planes of greatest and least chemical activity towards a given reagent. Next follows the still unsolved query as to the nature of the intercrystalline boundary, and the solution of these two problems will make it possible to define exactly the chemical character of a given aggregate of crystals. The results will be of extreme interest for the study of metallurgy, of minerology and of petrology, besides filling a serious gap in chemistry, serious because of the extent to which solids compose the world around us, and of the part which they play in our daily life.

BRITISH ASSOCIATION.

Southampton, 1925.

Section M.--Agriculture.

THE MINERAL ELEMENTS IN ANIMAL NUTRITION.

Address by J. B. Orr, D.Sc., (President of the Section).

Since the times of Lavoisier, research in nutrition has been directed chiefly to the chemistry of organic compounds, *i.e.*, proteins, fats, carbohydrates and allied substances, and in tables of rations the food requirements of animals have been expressed in terms of these or their equivalents. During the past half-century, however, an increasing number of workers have become interested in the *rôle* played by inorganic salts in nutrition. The information being yielded by the researches of these workers is throwing new light on many fundamental problems of biology, and some of the so-called mineral or inorganic salts in of it appears to be of potential economic value in animal husbandry. In this address an attempt is made to review some of the recently acquired knowledge, and to show its bearing on present-day practical problems of animal nutrition.

From 10 to 25 per cent. of living matter consists of organic compounds of which the colloidal material of the protoplasm is formed. The remaining 75 to 90 per cent. consists of water and inorganic salts. In

the recent literature of animal husbandry, the elements of these salts have been somewhat loosely termed 'the mineral elements' to distinguish them from the carbon, hydrogen, oxygen and nitrogen of the organic compounds.

About eight or nine of these elements, *e.g.*, calcium, phosphorus, potassium, etc., are always present in living matter in substantial amounts, and are known to be essential constituents. In addition to these, iodine, manganese, fluorine, copper, zinc, and some others are found in traces. The presence of these was at one time thought to be accidental. It is now believed, however, that most, if not all, are essential constituents of the tissues in which they are found, and that they perform important functions in metabolism.

In living matter these mineral elements are present, partly in chemical combination with, and forming an integral part of, organic compounds, and partly free or potentially free, either in solution as salts or ions in the water of the protoplasm, or in a temporary loose union with the colloids.

The fundamental nature of the functions life processes is at once apparent when we consider the part played by them in the origin of the cycle of energy exchanges which occur in the 'organic world.' All forms of life depend ultimately upon the transformation of the energy of the sunlight into chemical energy. The power of carrying out this fundamental process, which can be regarded as the real origin of life, is possessed by inorganic salts in colloidal solution. Photosynthesis with the production of formaldehyde, which contains the tapped energy of the sunlight, arises from the action of sunlight and inorganic salts on water and carbon dioxide. According to Moore, chlorophyll itself is a product of photosynthesis, and its chief function is probably not the primary one of deoxidising the carbon dioxide and thus charging the carbon with energy, but of changing the formaldehyde into higher carbon compounds. Hence the beginning of life-processes lies in the action of radiant energy on inorganic salts. The carbon atom is harnessed as the most suitable vehicle for conveying the chemical energy formed. The giant molecules and colloidal aggregates with their complex carbon containing compounds, which have been regarded as the fundamental organic substances, are really secondary developments to secure that degree of stability and complexity required for the evolution of higher forms of life. Thus the true basis of protoplasm is the saline solution which forms from 75 to 90 per cent. of its bulk and which still resembles the sea water from which it originated.

(*To be continued.*)

BRITISH ASSOCIATION OF SCIENCE 1925 (SOUTHAMPTON) TRANSACTIONS.

[ABSTRACTS.]

PROF. H. E. FIERZ. *The Distillation of Cellulose and Similar Substances in the presence of Catalysts under High Hydrogen Pressure.*

Cellulose, wood and starch can be distilled completely when mixed with sufficient nickel oxide and heated in hydrogen under a pressure of 100-250 atmospheres. Without pressure, and in the presence of only a small amount of nickel oxide, no result could be obtained. The best conditions were found to be 80 grams of nickel oxide and 500 grams of cellulose (wood, starch, sugar or lignin may also be used).

In the apparatus described pressures up to 4,000 atmospheres may be employed.

The products of distillation are very complex, consisting of about 80 per cent. clear mobile tar (ca. 9,000 calories), 80 per cent. of gas, and 10 per cent. of water. Analyses showed that practically no hydrogenation takes place. The tar contains 20 per cent. of phenols, 5 per cent. of lower fatty acids, and 70 per cent. of neutral compounds (furane and its homologues). In addition, there have been isolated small quantities of ketones, diketones, alcohols, and glycols, such as methyl, ethyl and propyl alcohols, acetone, methyl ketone, and a cyclo pentane diglycol. The residue remaining after the distillation was less than 2 per cent. of the cellulose employed.

Wood and lignin under similar conditions give a higher proportion of phenols and a lower proportion of neutral compounds than cellulose, whilst sugar and starch behave like cellulose. No conclusions with regard to the constitutions of the starting materials should be drawn from these experiments as the method of distillation is very drastic. It is, however, interesting that very large quantities of furanes are formed, since these occur also in ordinary wood tar, but have been overlooked previously because the products have always been purified by means of concentrated sulphuric acid, which destroys the furanes.

FARADAY SOCIETY.

The Photochemical and Thermal Decomposition of Ozone, by R. O. GRIFFITH AND A. McKEOWN (Liverpool).

(A contribution to a general discussion on *Photochemical Reactions in Liquids and Gases*, held by the Faraday Society at Oxford, October 1 and 2, 1925.)

ABSTRACT.

The endeavour to discover the mechanism underlying photochemical processes has been stimulated by the introduction of Einstein's photochemical law and the important work of E. Warburg based thereon. Among the substances whose reactivity has been studied in this connection ozone holds an important place. The decomposition of ozone has been investigated under a large variety of conditions, and whilst the behaviour is always somewhat complex, certain peculiar features of the deozonisation process appear to be more or less common to both the photochemical and the thermal reactions. It is the purpose of the present paper to correlate certain of these features, special attention being paid to the effect of the presence of other gases on the rate of deozonisation.

The decomposition of ozone by ultra-violet light (*circa* 253$\mu\mu$, the head of a strong ozone absorption band) has been investigated by Warburg, Weigert, and von Bahr. Warburg has found that the number of molecules of ozone decomposed per calorie of radiation absorbed (denoted by ϕ) depends to a marked degree on the concentration of ozone and on the nature of the diluent gas. In all cases, ϕ decreases with diminution of concentration of ozone, a limiting value being reached at concentrations of ozone of 0.5 per cent. by volume; the limit attained, however, is smallest in the presence of oxygen, about four times as great in the presence of nitrogen, and six times as great in the presence of helium. The total pressure in these experiments was one atmosphere. Weigert found that the order of the reaction was between one and two, depending on whether the light absorption was great or small. Von Bahr showed that the velocity of deozonisation by ultra-violet light is a function of the total pressure, a rapid increase occurring when the pressure is lowered below 200 mm.

The decomposition by visible light has been studied by Griffith and Shutt and Griffith and MacWillie. Owing to the small absorption capacity of ozone in the visible region of the spectrum, it was not possible to employ monochromatic illumination, and in order to secure a measurable decomposition, a light of strong intensity (wave-length limits 360μ -770$\mu\mu$) was used. The reaction was found to be bimolecular with respect to ozone. Substitution of part of the oxygen of an ozone-oxygen mixture by any one of the gases helium, argon, nitrogen, carbon monoxide and carbon dioxide, caused an increase in the velocity of decomposition.

The thermal decomposition of ozone, previously studied by Warburg, Clement, John, Perman and Greaves, and Chapman and Jones, has recently been reinvestigated by the present authors. Our observations at 100° indicate that the reaction is bimolecular, but that the velocity constant depends on the total pressure and on the composition of the gas mixture. Here the effect of addition of inert gases is similar to that found for the photo-reaction in the visible, while the effect of pressure is in the same direction as that found by von Bahr for the decomposition by ultra-violet light.

The decomposition of ozone may be photosensitised by addition of chlorine, as shown by Weigert and recently reinvestigated by Bonhöffer. The effective light in this case (in the region $\lambda = 416\mu\mu$) is strongly absorbed by chlorine, but practically not at all by ozone. The reaction is zero-molecular with respect to ozone, and Bonhöffer has found that each quantum absorbed by the chlorine results in the decomposition of two molecules of ozone. Bromine also acts as a sensitiser, but here about 30 molecules of ozone are decomposed per quantum absorbed by the bromine.

Finally, mention might be made of the phenomena accompanying the decomposition of ozone in presence of hydrogen. This has been investigated under the action of ultra-violet light by Weigert and Böhm under the action of visible light and thermally by Griffith and McKeown. In all three cases, two simultaneous reactions occur, ozone decomposition and water formation. The velocity of the former is found to be strongly and positively catalysed by the presence of hydrogen.

INSTITUTE OF MINING AND METALLURGY.

NOTICE OF MEETING.

The first ordinary general meeting of the thirty-fifth session of the Institution of Mining and Metallurgy will be held, by kind permission, at the rooms of the Geological Society, Burlington House, Piccadilly, London, W.1., on Thursday, October 15th, 1925, at 5.30 o'clock p.m.

The following paper will be submitted for discussion :--

Possible Improvements in Metallurgical Practice relating particularly to the Zinc Industry, by GILBERT RIGG, Member. (The paper to be illustrated by lantern slides.)

Tea, coffee and light refreshments will be provided at 5.0 p.m. for members and visitors attending the meeting.

DATES OF MEETINGS.

The succeeding general meetings of the session will be held at Burlington House on the following dates (Thursdays) :

November 19, 1925; December 17, 1925; January 21, 1926; February 25, 1926; March 18, 1926; April 15, 1926; May 20, 1926.

THE OPTICAL SOCIETY.

Imperial College of Science and Technology, South Kensington, S.W.7.

The next meeting of the Society will be held at the Imperial College of Science, Imperial Institute Road, South Kensington, at 7.30 p.m., on Thursday, 15 October.

The following papers will be presented and discussed :—

On Brewster's Bands, Part I., by PROF. C. V. RAMAN, F.R.S., and S. K. DATTA, M.Sc.

Lagrange's Theorem and Stationary Functions, by T. SMITH, M.A., F.Inst.P.

The following demonstration will be given by Mr. W. G. COLLINS, of the Cambridge Instrument Company, Limited :- -

A New Method of Recording Rapidly Varying Phenomena.

SOCIETY OF GLASS TECHNOLOGY.

The first meeting of the Society of Glass Technology for the session 1925-26, will be held in the Applied Science Department, The University, St. George's Square, Sheffield, on Wednesday, October 21, 1925, at 2.30 p.m.

The meeting will be preceded by a luncheon at 1 o'clock, at the King's Head Hotel, Sheffield.

PROGRAMME.

1.0 p.m. Luncheon, King's Head Hotel, Sheffield.

2.30 p.m General Meeting, Applied Science Department, The University, St. George's Square, Sheffield.

Presidential address by Mr. T. C. Moorshead, on "The Glass Industry and Future Developments." Discussion is invited.

NOTICES OF BOOKS.

Elementary Chemistry, by E. J. HOLMYARD, M.A., M.Sc., F.I.C. Pp. VIII. + 424. London : Edward Arnold and Co., 1925. Price 5s.

Mr. Holmyard states that he has written this introductory book to cover the syllabus of such now-standardised examinations as the London University Matriculation and the First School Certificate.

[We have just learned that a new syllabus will operate for London University Matriculation after 1927. It does not materially differ from the regulations now in force, so far as chemistry is concerned.]

As the author points out, writing to syllabus is not always commendable, but exception can well be taken in the present instance. The arrangement of the work does not quite follow traditional lines. A certain amount of repetition will be observed in several places. This is deliberate. It is almost hopeless to expect a young student to grasp an important fact or principle the first time he meets with it. In addition to revision exercises, questions on the work are given and the work is interspersed with interesting historical data and valuable illustrations.

The first two chapters, "What is Chemistry," and "How Chemistry Arose," make particularly refreshing reading. Their importance in the book cannot well be over-estimated, as they supply useful facts in stating the view point of the chemist. The paragraphs on "The Use of Chemistry," are especially important.

Mr. Holmyard writes well and makes the most of his subject, and this *Elementary Chemistry* should readily establish itself in the favour of those engaged in teaching the science.

J. G. F. D.

The Latest TRADE MARKS

The following list of latest Trade Marks Published is specially prepared for *The Chemical News,*" by Messrs. Rayner and Co., Regd Patent and Trade Mark Agents, of 5, Chancery Lane, London, who will give all information free regarding the Registration of British and Foreign Trade Marks.

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RECENT CANADIAN PATENTS.

253,709. Proces ansd apparatus for treating gases bearing gaseous synthetic ammonia. (Procédé et à traiter les gaz contenant de l'ammoniaque synthétique gazeux.) —The Atmospheric Nitrogen Corporation, assignee of Walter H. Kniskern, both of Syracuse, New York, U.S.A. 15 September, 1925. Filed 9 August, 1924. Serial No. 294,267.

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SPIRO COMPOUNDS WITH REFERENCE TO FORMATION AND STABILITY. PART V. RECENT WORK ON THE MULTIPLANAR NATURE OF THE CYCLOHEPTANE RING.

By R. F. HUNTER, M.Sc., D.I.C., A.R.C.S., A.I.C., F.C.S.

In Part III. of this series of articles (this *Journal*, 1924, CXXIX., 50), the experiments of Baker and Ingold on the multiplanar nature of the cycloheptane ring were discussed, since then some further experiments have been made by Baker (*Jour. Chem. Soc.*, 1925, CXXVII., 1678), which are of particular interest in this connection and which provide further evidence for the view that the cycloheptane ring is multiplanar.

The action of hydrolysing agents on $\alpha\alpha'$dibromo cycloheptane diacetic ester and of cycloheptanespiro 1-methoxy cyclopropane 1 : 2 dicarboxylic acid was examined by Baker (*loc. cit.*) with the object of obtaining either or both the acids (I.) and (II.).

$$\begin{array}{l} CH_2.CH_2.CH_2 \\ | \\ CH_2.CH_2.CH_2 \end{array} >C< \begin{array}{l} C(OH).CO_2H \\ | \\ CH.CO_2H \end{array}$$

I.

$$\begin{array}{l} CH_2.CH_2.CH_2 \\ | \\ CH_2.CH_2.CH_2 \end{array} >C< \begin{array}{l} CO.CO_2H \\ \\ CH.CO_2H \end{array}$$

II.

The relative stability of the acids (I.) and (II.) forms an important criterion respecting the condition of strain in the cycloheptane ring, for whilst in the gem dimethyl (this *Journal*, 1924, CXXIX., 288), and cyclopentane series (*The Chemical News*, 1924, CXXIX., 66), the open chain keto form is the stable modification, in the cyclohexane series, the strain in the three membered cyclopropanespiro ring is so far relieved that the hydroxy ring acid becomes the stable isomeride; in the intermediate cases, that is, in the gem diethyl series (*Jour. Chem. Soc.*, 1923, CXXIII., 118), and the gem di-n-propyl series (*ibid*, 1923 CXXIII., 1206), a tautomeric equilibrium exists between the open chain keto and the hydroxy ring form. If, therefore, the cycloheptane ring is uniplanar as used to be supposed, its hydroxycyclopropane compound (1) should be even more stable than the cyclohexane analogue. If, on the other hand, the seven membered homocyclic ring is multiplanar as previous work indicates, and therefore strainless, or at least nearly so, it should resemble more closely the cyclopentane analogue, and, therefore, the keto acid (II.) should be the stable form.

Actually the results of Dr. Baker's experiments indicate that the cycloheptane ring is strainless, or nearly so, for the open chain keto acid (II.) was the more stable isomeride, the hydroxy ring acid (which was isolated) passing into the keto acid under the conditions in which this reversible isomeric change has been observed in other cases.

In a hydrolysis of the dibromo ester with boiling methyl alcoholic potash (*loc. cit.*), the methoxy ring acid analogous in all respects to the corresponding cyclohexane compound was obtained, this on hydrolysis with hydrobromic acid, gave a large yield of a liquid acid and a small yield of solid acid which was identified as cycloheptanespirocyclopropane 1 : 2 dicarboxlyic acid, the hydrobromic acid apparently having acted as a reducing agent. The liquid acid was purified through its silver salt and proved to the hylrated form of the keto acid (II.) for it readily yielded a semi-carbazido acid with semicarbazide acetate. Hydrolysis of dibromocycloheptanediacetic ester with 64 per cent. aqueous

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

potash yielded a small amount of the ring acid (I.) (about 1 %), a large quantity of the keto acid (II.) and a liquid lactonic product. From which it appears that in the presence of hot concentrated alkalis a tautomeric equilibrium greatly favouring the open chain keto form exists between the acids (I.) and (II.)

The cycloheptane compounds therefore closely resemble the cyclopentane derivatives (*loc. cit.*), which contain a nearly strainless ring system, from which it can be asserted that the cycloheprane ring is also strainless or at least nearly so.

It is curious that the cycloheptane ring shows no evidence of strainless configuration until joined to another ring in some combination as represented by decahydronaphthalene. This can, of course, be accounted for if it is assumed with Mohr *J. pr. Chem.* 1918, IIC., 352) that these rings undergo vibrational interchange between the strainless and uniplanar phases, and further postulate that the uniplanar phase, which is more highly strained in the cycloheptane than in the cyclohexane series is, for that reason, of much smaller duration in the former than in the latter type of ring.

In connection with this work it is of interest to note that the experiments of Spiers and Thorpe on the influence of valency direction on the dissociation constants of dibasic acds (*Jour. Chem. Soc.*, 1925, CXXVII., 538), indicate that the cycloheptane ring lies in one plane, since from electrical measurements of the conductivity of dibasic acids, the deflecting effect of the cycloheptane ring on the tetrahedral angle appears to be in accordance with the view that the cycloheptane ring is uniplanar.

Highbury New Park, N.5.

FUNGOUS INFECTION OF SEED CORN KERNELS AND THE IMPORTANCE OF GERMINATION TESTS.

C. W. Edgerton and A. F. Kidder.
(Louisiana State University and A. and M. College.)

While corn is one of the major agricultural crops of Louisiana, the low yields make it of less importance than it should be. The yields in the State for the past ten years have varied between sixteen and twenty-two bushels per acre, and these are too low for much profit.

Without doubt there are many factors responsible to a more or less extent for the low yields. Among these should be mentioned soil fertility, cultivation methods, drainage conditions and the attack of insects and diseases. There is no way at present of telling the relative importance of any of these factors. In varying degrees, these factors are influenced by one another.

One of the factors which has received considerable attention in recent years by workers in other states and in the Federal Department of Agriculture is the infection of seed corn grains with certain fungous parasites. A number of bulletins and articles have been published showing the relation of this infection to vitality, germination, grain production and the amount of root rot on the growing plants. Briefly, the results from various places seem to show that a considerable portion of the corn in the United States is infected with fungi, and it is generally assumed that this infection affects the germination of the seed and the yield of the crop. Consequently, it has been generally recommended that corn which does not show a high germination or does not produce plants of rapid and strong growth in the germinator should not be used for seed.

As preliminary tests had shown that Louisiana corns were badly infected with some of these fungi, experiments were planned to determine how important this factor is to the corn crop of the State. The experiments have run over a period of four years. The things which we have tried to bring out in these tests include the following:

(1) The percentage of Louisiana corn, and especially seed corn, that is infected with each of the common fungi.

(2) The effect of this infection upon germination and yield.

(3) The relation between the apparent vitality of the corn as shown by germination tests and yield.

Fungi in Corn Grains.

Tests made in various parts of the United States have shown that four fungi are commonly found inside the grains of corn. The fungi are in the mycelial stage and are generally within the seed coats at the tip of the kernel, evidently growing into the kernels while the ears are maturing. The fungi mentioned as occurring in most abundance are *Gibberella saubinetii*, *Diplodia zeae*, *Fusarium moniliforme* and *Cephalosporium acremonium*.

Gibberella saubinetii is a common parasite of small grains and corn, causing the common scab of wheat and one of the root rot diseases of corn. It is widely distributed in the corn belt area of the United States, but has apparently not been reported in Louisiana.

Diplodia zeae is the cause of the common dry rot disease of corn ears. The ears rot and the shucks are generally cemented together and to the rotting kernels by a white mould or mycelium. This fungus is common in most parts of the United States, including Louisiana.

Fusarium moniliforme is the fungus which produces the common pink rot of corn kernels. It is widely distributed over the United States, including Louisiana.

Cephalosporium acremonium is a fungus which seems to be widely distributed over the United States, including Louisiana. This is the same fungus which Manns in recent publications called *Cephalosporium sacchari*. *C. Sacchari* is a sugar cane fungus and apparently has no connection with the corn parasite.

In determining the presence of fungi in Louisiana corns, practically the same procedure has been followed as has been used at other stations. The grains were first soaked for three to five minutes in a corrosive sublimate alcohol solution. The corrosive sublimate was at the strength of one to one thousand, this being dissolved in a 50 per cent. alcohol solution. Then, after thoroughly rinsing in sterile water, the kernels were placed in nutrient media in petri dishes and allowed to incubate. If any fungi were present, the mycelium would grow out on the culture media and could be identified after a period of six to nine days. During the later years of the work, a drop of 50 per cent. lactic acid was dropped into each agar tube before pouring into the petri dish. This eliminated a large part of the bacterial contamination and did not hinder the growth of any of the important fungi. Corns from three successive crops have been tested.

In order to obtain the general distribution of the kernel infection, samples were obtained from a large number of the corn exhibits at the State Fair at Shreveport in the fall of 1921. This corn had all been closely selected and was, of course, above the general run of corn in soundness and freedom of rot. The samples were from various parts of the State and represented the best of the Louisiana corn for that season. These were brought to Baton Rouge and were cultured in the manner described above, 16 to 20 kernels of each sample being used. Various other fungi, such as Aspergillus and Penicillium, were also present to a certain extent, but neither these nor the bacterial contaminations seem to be important. As acid was not used in the plates, it was not always possible to eliminate all bacterial growth.

Summary.

1. Corn yields in Louisiana are relatively low. There are a number of factors responsible to a more or less extent for these low yields.

2. Many corn grains are internally infected with certain fungous parasites and this fungous infection has often been considered as an important factor in corn production.

3. Four fungi have been described as commonly occuring in corn grains. These are *Fusarium saubinetti*, *Diplodia zeae*, *Fusarium moniliforme* and *Cephalosporium acremonium*.

4. *Fusarium saubinetti* has not been reported in Louisiana. *Diplodia zeae* occurs abundantly in Louisiana, but ears affected with it are seldom used for seed.

5. About 50 per cent. of the corn kernels used for seed in Louisiana are infected with *Fusarium maniliforme*, and about 80 per cent. with *Cephalosporium acremonium*.

6. From three years' tests it would seem that neither *Fausarium moniliforme* nor *Cephalosporium acremonium* has any marked effect on stand or yield in Louisiana.

7. To a certain point, the yield of corn in Louisiana is directly proportional to the stand.

8. From one year's test, the fungous infection of the grains seems to have no effect on the suckering of the plant, nor does the presence of suckers seem to have any effect on the yield of the individual plants. A better stand was maintained with plants that suckered freely.

9. The laboratory germination test is not a good index of what corn will do in Louisiana.

10. Better stands in the field, and consequently higher yields, were obtained with corn that showed well in the germination tests, but the individual plants produced no better than plants from corn that showed a poor germination test.

11. From a single year's test, smooth ears give better stands and higher yields than rough-dent ears. Furthermore, the individual plants produce slightly more.

A HOT-WIRE ANEMOMETER FOR MEASURING AIR FLOW THROUGH ENGINE RADIATORS.

By CARL G. F. ZOBLL AND L. B. CARROLL (U.S.A. Bureau of Standards).

In connection with tests being conducted on airplane radiators at the Bureau of Standards on behalf of the National Advisory Committee for Aeronautics, a portable instrument was required to measure the average flow of air through radiators mounted in different positions on an airplane. For this purpose an anemometer was constructed, which consists of a grid of platinum wires heated by an electric current from a storage battery.

The flow of air cools the wires, and the amount of electric current necessary to maintain them at some definite temperature serves to measure the velocity of air flow.

The air velocity can be measured to within 5 per cent. if the grid of wires is placed immediately in front of the radiator or at least 12 inches back of it. Turbulence of the air immediately back of the radiator interferes with correct measurements.

The only electrical measuring instruments necessary for reading the air velocity by this means are an ammeter and a voltmeter.

In connection with some radiator problems presented by the National Advisory Committee for Aeronautics, a hot-wire average flow of air through radiators mounted in different positions on an airplane. The heat dissipation from a hot wire to a gas stream has frequently furnished a means of measurement of the velocity of flow of a gas.

King's equation for the heat loss from a cylinder cooled by a stream of fluid was derived by solving Boussinesq's general differential equation for the conduction of heat in a moving fluid assuming the boundary condition of constant flux.

Except for very smal wires and extremely low velocities

$$H = K\Theta + 2\sqrt{\pi K S \sigma A V}\,\Theta \qquad (1)$$

where

H = heat loss per unit length of cylinders, $\dfrac{\text{cal}}{\text{sec.} \times \text{cm.}}$

K = conductivity of the fluid $\dfrac{\text{cal}}{\text{sec.} \times \text{deg. C.} \times \text{cm}}$ (assumed independent of temperature and, therefore, constant)

Θ = Temperature difference between the cylinder and the stream, deg. C.

S = specific heat per unit mass of the fluid, $\dfrac{\text{cal}}{\text{g} \times \text{deg. C.}}$

σ = density of the fluid $\dfrac{\text{g}}{\text{cm}^3}$

A = radius of cylinder, cm

V = velocity of stream, $\dfrac{\text{cm}}{\text{sec.}}$

Since all quantities under the radical are assumed constant for a given fluid and cylinder, for a specific instruments equation (1) may be written more simply

$$H = \Theta(K + b\sqrt{V}) \qquad (2)$$

The results of King's experimental work support the validity of this formula.

THE USE OF LIQUID AMALGAMS IN VOLUMETRIC ANALYSIS, PART II. OXIDIMETRIC ESTIMATION OF TUNGSTEN, ETC., BY USING LEAD AND BISMUTH AMALGAMS.

By KINICHI SOMEYA.

In his first communication the writer has described the principles and the methods in the use of liquid amalgams in volumetric analysis, together with some applications of zinc and bismuth amalgams. The present paper deals with some of his further observations on the reducing action of lead and bismuth amalgams, which furnished him a basis for some new methods of oxidimetric determination of iron, titanium, uranium, molybdenum and tungsten.

Liquid lead amalgam reduces ferric and uranyl salts to ferrous and uranous ones, and molybdic, titanic and tungstic acids respectively to their tervalent condition, and by utilising these properties methods for their oxidimetric determinations were worked out.

Liquid bismuth amalgam reduces tung-

stic acid quantitatively to the pentavalent condition, which fact can also be utilised in the estimation of tungsten.

Cadmium and zinc amalgams also reduce tungstic acid quantitatively to the tervalent condition.

In conclusion the writer wishes to express his heartfelt thanks to Prof. Honda, who gave constant interest and encouragement to his work, to Prof. Kobayashi for his useful suggestions, and also to Mr. Kato for his enthusiastic help during the course of his work.

UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR ASBESTOS HIGH-PRESSURE ROD PACKING.

(U.S.A. Bureau of Standards.)

Grades.

Packing shall be supplied in one grade only.

Material and Workmanship.

1. Packing shall be made from woven asbestos cloth, treated with a protective coating of rubber compound, wrapped tightly upon itself, in layers. No wire insertion will be permitted.

2. It shall be square and shall be made plain, with a central rubber core, or with a rectangular rubber spring back as specified, and shall be sufficiently pliable to move or flow toward the rod as wear takes place. Packing less than ¼ inch in size shall not contain a rubber core or spring back.

3. When the packing is made with a rubber spring back, the outside cover stock shall consist of not less than two complete layers of cloth.

4. Rubber friction shall not be used on the outside of the packing where it will come in contact with the rod.

General Requirements.

The general requirements shall be as stated in Section IV.

Detail Requirements.

1. The asbestos cloth shall be made as follows: Each strand of the warp and filling shall consist of two asbestos yarns, and the weave shall run not less than 20 strands of warp and not less than 10 strands of filling per linear inch.

2. The yarn shall contain not less than 90 per cent. of long fibre asbestos of not less than 12 per cent. water or composition.

3. New wild or plantation rubber of best quality shall be used in the spring back, central core, and friction.

4. The compound used for the spring back or central core shall contain not less than 60 per cent. by volume of rubber. The total sulphur, exclusive of that contained in barytes, shall not exceed 8 per cent. of the weight of rubber as compounded. The rubber compounds shall be free from all substances which might injuriously affect the quality.

5. The packing shall be coiled into helices and vulcanised. The inside diameter of the helix shall be not less than four times nor more than six times the thickness of the packing.

6. Packing with core or spring back shall contain not less than 40 nor more than 60 per cent. by weight of rubber compound including the core or spring back, prior to lubrication. Packing without core or spring back shall contain not less than 30 nor more than 50 per cent. by weight of rubber compound prior to lubrication.

7. The cross-sectional area of the rubber core or spring back shall not exceed 12 per cent. of the nominal cross-sectional area of the packing.

8. The lubrication shall not exceed 20 per cent. by weight of the finished packing. Lubrication may be either oil or glycerine.

9. The finished packing shall be dipped in pure flake graphite.

10. When subjected to the action of a saturated steam at 250 lbs. per sq. in., gauge pressure for eight hours, the finished packing shall not harden nor soften materially, and the friction compound shall retain most of its elasticity and strength as indicated by the "tooth" when the plies are separated.

Methods of Inspection and Test.

1. A sample of untreated cloth 12 inches square shall be taken fro meach lot.

2. A sample 12 inches long of each size of packing as finished, and also without lubrication or graphite, shall be taken from each 1,000 pounds or less.

Packing and Marking.

Each helix of packing shall be wrapped in waxed paper.

Additional Information.

1. This packing is suitable for use as a piston rod, valve stem, or slip-joint packing under steam pressures up to 300 lbs. per sq. in, and with a maximum temperature of 700° F.

2. The packing as furnished shall weigh within 5 per cent., plus or minus, of the

proposed weights as submitted with the proposals.

GENERAL SPECIFICATIONS.

All tests and analyses shall be made in accordance with the methods described in United States Government General Specifications for Rubber Goods, F. S. B. Specification No. 59a, in effect on date of proposal.

VATERITE AND μ-CALCIUM CARBONATE.

By RALPH EDWARD GIBSON, RALPH W. G. WYCKOFF AND HERBERT E. MERWIN.

(October *American Journal of Science*.)

Two crystalline forms or habits of anhydrous calcium carbonate, differing essentially from the well-known modifications, calcite and aragonite, have been described and have formed the subject of considerable controversy. These are *vaterite* and *μ-calcium carbonate*.

In 1916 Johnston, Merwin and Williamson gave very definite evidence in favour of the existence of μ-$CaCO_3$ and at the same time came to the conclusion that vaterite is nothing more than spherulites of fibrous calcite. According, however, to sundry considerations emphasised by Spangerberg, and by the X-ray analyses of Rinne and of Heide, it seems that vaterite is really a crystalline species distinct from calcite and aragonite. Both Spangenberg and Heide, moreover, cast grave doubts on the existence of μ-$CaCO_3$.

A critical examination of the literature on "Vaterite" has shown that this name has been applied to two entirely different spherulitic habits of calcium carbonate. The first of these, which was investigated by Vater and later by Johnston, Merwin, and Williamson, has now been shown, by X-ray powder photographs, definitely to be calcite, thereby confirming the conclusion of the last-named authors. The second, which was studied by Butschli, Spangenberg, Rinne and Heide, has proved to be essentially μ-calcium carbonate.

A reliable method for the preparation of distinct crystals of μ-calcium carbonate in fairly large yields has been obtained. The principal lines in the X ray powder photographs of this modification are given. Reviewing all the work in this field, therefore, we are able to state that anhydrous calcium carbonate may exist at ordinary temperature and pressure in three distinct crystalline forms, calcite, aragonite, and μ-calcium carbonate.

General Notes.

LEEDS UNIVERSITY.

An appeal has been issued for funds to enable necessary extensions and improvements to be made in the Leeds University. Founded in a modest way in 1826, the University has grown until it is now a great centre of learning, of which all Yorkshire men are justly proud.

The University has 42 Departments of study, grouped in the four faculties of Arts, Science, Technology, and Medicine.

The academic staff of 268 men and women includes 38 professors, 7 readers, 115 lecturers, and 108 assistant lecturers, demonstrators, instructors, and research assistants.

The full-time students in 1923-24, numbering 1,475 (in addition to which there were 203 part-time day students and 236 evening students), were divided amongst the faculties as follows:

Faculty of Arts	472
Faculty of Science	323
Faculty of Technology ...	296
Faculty of Medicine	384

Of the full-time students, 1,068 were men and 407 women. 489 came from the County Borough of Leeds; 404 from the West Riding County Area; 304 from other parts of Yorkshire; 192 from other parts of England, Wales, Scotland and Ireland; and 76 from overseas.

The appeal is for half a million, which could be spread over the next five years, during which time the various buildings and extensions will, it is anticipated, be completed. While the appeal is made specially to Yorkshire men and women, it is hoped that the response will come also from a much wider constituency, as the cause is one eminently worthy of support.

INCREASING PIG IRON OUTPUT IN THE U.S.A.

The production of pig iron in September amounted to 2,726,000 tons, against 2,704,000 tons in the preceding month, and 2,053,000 tons in September last year, the weekly average being 644,000 tons, against 611,000 tons and 506,000 tons respectively.

MINERAL PRODUCTION OF CANADA DURING THE SIX MONTHS ENDING JUNE 30, 1925.

By W. H. LOSEE, B.A., AND B. R. HAYDEN, under the direction of Mr. S. J. COOK, B.A., etc.)

Outstanding advances among the metals, marked the mineral production records for Canada during the first half of 1925. Production of metals and non-metals reached a total value of $90,347,698 as compared with $84,307,385 in the first half of 1924, an increase of 7.16 per cent. Metals and non-metals produced during the calendar year 1924 were valued at $174,202,537; production during the first half of 1925 showed a sum equal to 51.86 per cent. of this total.

Coal, gold, lead, nickel, copper, silver, zinc, asbestos, natural gas and cobalt, were in the order named, the principal products of the mineral industry in Canada during the period under review, production values for these commodities ranged from $21,445,597 for coal to $1,239,188 for cobalt and amounted in the aggregate to $87,635,008 or 96.99 per cent. of the grand total for metals and non-metals. No other products in this class reached a value in excess of a million dollars during the half-year.

In the first half of 1924 a loss in coal production of more than 2 million tons was reported; in the first half of 1925 there was a further reduction of 1.46 million tons due to the great strike in the Nova Scotia coal mines which began early in March and continued beyond the end of the half-year.

Canada's production of coal totalled 5,383,714 tons, valued at $21,445,597 as compared with 6,847,665 tons, valued at $27,135,623, in the first half of 1924.

Based on figures of output, imports and exports, the computed amount of coal made available for consumption in Canada during the first half of 1925, was 11,689,998 tons as compared with a total of 18,864,087 tons made available for use in the half-year ending June, 1924. On the same basis, the total supply made available during the twelve months ending June 30, 1925, was 27,519,440 tons; at the end of June 30, 1924, the total for the twelve months was 33,876,975 tons.

Gold production reached a new record at 824,043 fine ounces, which valued at the standard rate of $20.671884 per fine ounce was worth $17,034,480 as compared with 700,264 fine ounces worth $14,475,741 produced in the vrst half of 1924.

Rising to a total of 128,398,886 pounds, the production of lead in the first six months of 1925 reached a total value of $11,510,955 and marked an increase of 49,340,541 pounds in quantity and $5,232,145 in value above the total for the six months ending June, 1924.

The production of nickel in Canada during the half-year ending June amounted to 35,756,640 pounds, which while slightly less than the production during the first six months of 1924, amounted to 51.4 per cent. of the total for the calendar year. At 32 cents, the aevrage New York price for 99 per cent. virgin metal during the half-year, production was valued at $11,442,125.

Copper production, computed as the sum of the quantity of copper contained in matte made in the Sudbury area, the blister copper produced at the Granby smelter in British Columbia, and the recoverable copper ores exported, amounted to 53,055,349 pounds, valued at $7,354,533.

Better prices for silver prevailed during the half-year, so that, with production slightly above the total for the first six months of 1924, the value of silver produced during the period reached a total of $6,288,382, as compared with $5,881,196 in the corresponding period of last year.

Zinc refined at Trail, B.C., with relatively small amounts of zinc estimated as recoverable from ores exported from British Columbia, Ontario and Quebec made up the total of 55,257,772 pounds produced from Canadian ores during the first half of this year.

Asbestos shipments totalling 120,800 tons worth $3,962,804, marked an advance over the 104,872 tons at $3,192,132 shipped during the first half of 1924.

For the first time in history, Alberta won first place among the provinces as a producer of natural gas with a production of 4,687,084 M cu. ft., displacing Ontario, which had previously held the premier position; Ontario's output in the first half of the year was 3,257,429 M cu. ft. There was also a small production from New Brunswick wells. Production from all Canadian wells during the half-year amounted to 8,381,104 M cu ft., valued at $3,354,672, a decrease of 4.25 per cent. in value as compared with the totals for the half-year ending June 30, 1924.

Canada continues to be the main source

of the world's supply of cobalt. Computed as the sum of the cobalt contained in metal, oxides, salts, ores, concentrates and residues marketed during the period, the production of cobalt in the first half of 1925 amounted to 590,087 pounds, netting the producers $1,239,133. On the same basis, production during the calendar year 1924, amounted to 948,704 pounds, valued at $1,682,895.

Other metallic mineral products deserving of mention were white arsenic, of which more than 2 million pounds were made; bismuth, contained in silver lead-bismuth bullion exported; small quantities of iron ore and of pig iron made from Canadian ore; and a recovery of precious metals belonging to the platinum group worth $80,706.

Non-metallic mineral products, other than those produced in sufficient quantity to place them among the ten most important mineral products during the half-year, were barytes, feldspar, graphite, gypsum, magnesite, mica, mineral waters, iron oxide pigments, crude petroleum, pyrites, quartz, salt, sodium carbonate, sodium sulphate, talc and soapstone. Of these, there are a few which specially merit attention.

LIQUEFACTION OF COAL AS A SOURCE OF MOTOR FUEL.

With the multiplication of methods of motor travel land, sea and air and the threatened diminution of the available supply of petroleum, the problem of increasing the world's liquid fuels is becoming more and more urgent. In the United States, France and Great Britain more and more attention is being paid to the mass production of vegetable growth, rich in carbohydrates, susceptible of transformation by fermentation into ethyl alcohol.

German chemists are concentrating their studies on converting a larger percentage of coal into liquid fuel than is now the case, when subjective to destructive distillation as in coke ovens. These latter furnish to-day 1% of the world's liquid fuel. As long as the coking of coal produces but 5% of the weight of the coal in tar it is useless to expect much help from existing methods. Attempts to suspend finely powdered coal in oil have failed to furnish a liquid capable of serving as a motor fuel. Other attempts to dissolve coal or partly oxidise it have likewise been unsuccessful in supplying any practicable amount of liquid fuel.

Dr. Gergius of Heidelberg, has succeeded in transforming no less than 80% of ordinary coal liquids, gases and soluble substances, by heating it to 480° C. under a pressure of 100 atmospheres, in autoclaves or bombs. A certain quantity of oil about 35% is mixed with the finely ground coal to facilitate the transmission of heat and prevent coking. This oil is taken from the product and returned to it. The presence of a little ferric oxide acts also as a preventative of coking.

The production of oil by this process varies from 45% to 70% of the weight of the coal. Thus, a metric ton of dry coal containing 4% of ash, treated with 5% of hydrogen, yielded 455 kg. of oil, 210 kg. of gas, 75 kg. of water, 5 kg. of ammonia, and 350 kg. of residue. This residue, when coked, supplied, further, 80 kg. oil, 240 kg. coke, and 25 kg. gas.

The oil consisted of 150 kg. gasoline or benzine for motor use, 200 kg. Diesel oils, and some residual heavy fuel oil. The gas was chiefly methane, mixed with some hydrogen, used in subsequent operations. An operation lasts 15 minutes. Apparatus is now in use for continuous operation.

Three tons of coal (including 1 ton for motive power, heating, etc.), yields one ton of oil costing about $48.00. This means an average cost of the oil products of about 12½ cents a gallon, a relatively low price for gasoline in Europe and close to American production costs. *Chemicals.*

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section M.—Agriculture.

THE MINERAL ELEMENTS IN ANIMAL NUTRITION.

Address by J. B. Orr, D.Sc., (President of the Section).

(Continued From Last Week.)

The brilliant researches of Ringer, Hardy, Moore, Loeb, Höber and others have shown that these inorganic elements play a vitally important part in all physiological processes, and that the hidden mysteries of cell life which are slowly being unravelled are intimately connected with their activities. The fundamental facts revealed by these workers are perhaps the most important results obtained in research

in biology in modern times. They throw new light on the nature of the vital processes, which are shown to be phenomena capable of explanation in terms of the comparatively simple laws which obtain in 'inorganic' systems. It is impossible here, however, to do more than refer briefly to the nature of the functions of the inorganic salts and ions.

As has been already indicated, these functions are intimately connected with colloidal activities, The visible phenomena of life are the resultants of an enormous number of chemical and physical changes in the colloids of protoplasm and of exchanges between masses of protoplasm separated by membranes and interfaces. But these changes in the physical state of colloids are determined by the association and dissociation of colloids and inorganic ions. These ions also affect the permeability of membranes and the tensions at interfaces. Hence, in a real sense, protoplasmic activity is regulated by the action of the mineral elements in solution in the protoplasm or attached to its colloids. Thus, in the contraction of muscle, though the ultimate source of energy is the oxidation of organic compounds, the initiation of the process, the mechanism by which it is carried through and the factors by which it is controlled, depend on the action of the ions and salts present which involve changes in osmotic pressure and other physical forces.

The foregoing considerations suggest that definite degrees of concentration of the various inorganic ions in the cell fluids are necessary for the maintenance of normal protoplasmic activity. This has been fully demonstrated by work done to determine the effect of changes in the normal concentration of the different ions. The results of experiments with unicellular organisms and with isolated organs such as the perfused heart, have shown that slight alterations either in the absolute or relative concentrations of any of the inorganic ions may accelerate, retard, or even reverse processes being carried out by means of the colloidal mechanism.

In the animal body these changes in the concentration of the inorganic ions can be correlated with changes in the functions of the organs. Thus, all the organs regulated by the central nervous system depend for the integrity of their functions upon the maintenance of definite ratios of calcium, potassium, and sodium in the fluids within the nerve tissues. Changes in the relative proportions of these are accompanied by alteration in the excitability of nerve and irritability of muscle. The classical experiments of Ringer on the perfused heart show that minute changes in the concentrations of calcium or potassium in the perfusing fluids have a profound effect on the acitvity of the heart. These examples are merely illustrations of the general law that any disturbance of the normal physiological balance of the salt solution of the body is accompanied by a correlated impairment of function.

There is both experimental and clinical evidence to show that changes in the physiological balance are involved in many pathological conditions in which the symptoms can be associated with excess or deficiency of specific ions. Some of these pathological conditions, such as rickets, can be produced experimentally in animals fed on ill-balanced diets, and the symptoms can be relieved by adjusting the diet so that the essential mineral elements are absorbed from the intestine in the right amounts and proportions.

The body is remarkably efficient in maintaining this balance, in spite of the fact that there is a continuous loss in the excreta, and the mineral matter of the food is liable to be very different in composition from that found in the blood. Within limits, the elements present in excess tend to be excreted and those deficient to be conserved. The bones act as a reservoir, especially for calcium and phosphorus, the two required in largest amounts. Reserves can be deposited in the bones when the supply is ample, and mobilised in times of need. It is probable that this function of the bones, *viz.*, regulating the supply of mineral elements to the body fluids, is as important as the more obvious one of providing a rigid framework. It is probably more fundamental, for, when the available mineral matter is insufficient to maintain both the physiological balance in the blood and the rigidity of the skeleton, it is rigidity which is sacrificed. There is little doubt that in most diseases affecting the bones, the skeletal symptoms are only secondary manifestations of the influence of some factor, often a dietary one, which upsets the balance of mineral elements in the blood.

We have seen that the presence in the body fluids of mineral elements in definite amounts and proportions is a necessary condition of health, and that the body possesses means of regulating this physiological balance. We must not consider what occurs when there in the diet

deficiencies or excesses of mineral elements greater than can be dealt with by the regulating mechanism of the body. .

Let us note first the widespread and drastic results of more or less complete privation of all mineral elements. Forster studied the effects of feeding a diet from which the mineral salts had been removed as completely as possible. He found that on this diet animals died sooner than in complete starvation. Signs of disturbance of the digestive organs appeared early. They were soon accompanied by increased excitability and weakness of the neuromuscular system. The central nervous system was also affected, as was shown by the occurrence of convulsions and periods of drowsiness. A remarkable feature of these experiments was the profound disturbance caused by relatively small losses of inorganic salts from the system. The total mineral matter of the body at the beginning of the feeding with the salt-free diet was estimated at 1.500 grams. Phosphoric acid and sodium chloride were lost in greatest amounts, and of these only about thirty grams and seven grams respectively were lost before death occurred. A well-nourished body could lose a far larger proportion of its total protein, fat or carbohydrate without showing any marked disturbance of its functions.

A number of workers have studied the results of prolonged feeding of a diet containing a marked excess of acid radicles, and have found that, under such conditions the body tends to be depleted of bases, and when a certain stage of depletion has been reached, there appear signs of disturbance of the fucntions of the digestive and nervous systems and loss of weight. The regulating mechanisms of the body, however, are able to deal with a considerable excess of acid in the food, and opinion is divided as to the extent to which, in actual practice, excessive acidity of the diet is a factor in causing malnutrition. It is probable that, if evil effects do occur, they will be most marked during the period of active growth, because an excess of bases is required for tissue construction.

Deficiencies of single elements, or of groups of elements, in the diet, are followed by more or less characteristic symptoms, which, however, are modified by the presence or absence of other factors. It is interesting to note that, in many cases, the pathological symptoms due to deficiency of individual elements, such, for example, as the hyper-excitability which occurs in calcium deficiency, can be explained by the influence of the ion concerned on the colloids of the tissues or on the permeability of membranes.

Under experimental conditions it is possible by feeding diets with marked deficiencies or excesses of some of the mineral elements, to produce conditions of malnutrition which are so definite and marked that they are as easily recognised as definite diseases; indeed, similar conditions occurring in practice are regarded as definite diseases. Thus, primary anæmia, simple goitre and rickets are produced by deficiency of iron, iodine and either calcium or phosphorus respectively. An interesting case of a disease due to an excess of a mineral element is reported by McCollum, who regards an inflammatory condition of the eyes, resembling xerophthalmia, which he calls ‘ salt ophthalmia,’ as due to excess of chlorine in the food.

In addition to these diseases due to excesses or deficiencies of mineral elements in the diet, in which the symptoms form a definite and easily recognised picture, and the cause is admitted, there are conditions of malnutrition due to the lack of balance of the mineral elements in the diet, where the signs are much less obvious. In young animals there may be retarded growth without any definite pathological symptoms. The only reason for supposing that such animals are not in a perfect state of health is that their rate of growth is not optional, as is shown by the fact that improvement follows the adjustment of the mineral balance in the food. Thus, Kellner obtained an increased rate of growth in calves by the addition of a calcium salt to a diet on which the animals grew at an average rate and showed no signs of obvious ill-health. In some work, not yet reported, we have found that the addition of traces of iodine to the diet of stall-fed calves in winter increased the rate of growth as compared with that of control animals whose condishown recently that the supply of minerals in the food of the mother may have a profound influence on the vitality of the young at birth and for some time after, even where there may be no obvious effect on the mother. Thus Hart, Steenbock, and Humphrey have noted that deficiency of calcium in the diet of cows may lead to the birth of dead or weakly calves and Ennis Smith has shown that deficiency of iodine in the food of pigs may lead to the birth of dead young, although there is not,

in either case, any obvious pathological condition apparent in the mothers.

Some attention has recently been devoted to the question of an increased susceptibility to certain infectious diseases in cases of malnutrition due to deficiencies of minerals. We have noted in feeding experiments that the mortality from intercurrent infections is much higher in the groups fed on diets which, for experimental reasons, are ill-balanced or deficient in mineral matter. Meigs has noted a similar incidence of diseases in cows on diets deficient in calcium. In clinical medicine the administration of inorganic salts of calcium, iodine and manganese has been advocated in the treatment of certain bacterial infections. It is very probable that such treatment is efficacious where these salts are deficient in the body and that its efficacy is due to the making good of that deficiency. It has been suggested that deficiency is calcium may be a causative factor in producing a lowered resistance to tuberculosis. If this is correct it is of great economic importance on account of the incidence of tuberculosis in dairy ows. It is known that, at the height of lactation, there is usually a loss of calcium from the body. This is greater the higher yield of milk, and tuberculosis seems to be more liable to occur in heavy-milking cows.

(To be continued.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, October 7, 1925. Mr. E. M. Hawkins, vice-president, was in the chair.

Certificates were read for the first time in favour of Messrs. Alexander Bruce, B.Sc., F.I.C., Felix John Theodore Grigg, M.Sc., A.I.C., Sydney George Clarke, B.Sc., A.I.C., John Hanley, F.I.C., Arthur John Jones, A.I.C., Henry William Lawrence, F.I.C., Fred Mattingley, B.Sc., A.I.C., Bartle Frere Sawbridge, M.A., F.I.C., Harold Jacob Stern, Ph.D., B.Sc., A.I.C., and Major Clive Newcomb, M.D., F.I.C.

A certificate was read for the second time in favour of Mr. Theodore Rendle.

The following were elected Members of the Society :- As honorary Member, Professor George Gerald Henderson, M.A., D.Sc., F.R.S., F.I.C.; as ordinary members, Messrs. Lewis Eynon, B.Sc., F.I.C., Jack Rowan Heather, Frederick George Hitchman, and William David Rogers, B.Sc., F.I.C.

Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates :

III. *A New Method for the Separation of Tantalum from Niobium.*

IV.- *The Detection and Determination of Tantalum in Niobium Compounds.*

By A. R. Powell and W. R. Schoeller, Ph.D.

The method is based upon the differential hydrolytic dissociation of oxalotantalic and oxaloniobic acids in presence of tannin in slightly acid solution. The former, on boiling, yields a sulphur-yellow tannin adsorption precipitate, whilst oxaloniobic acid is only dissociated at a much higher concentration and lower acidity, with precipitation of a bright vermilion adsorption tannin complex. On adding oxalic acid to the boiling liquid, the niobium precipitate is readily redissolved, whereas the tantalum precipitate is only redissolved at a much higher H-ion concentration. Co-precipitation of the niobium is overcome by fractionation and re-precipitation.

The tannin method can also be used for the detection, as well as the determination, of small amounts of tantalum in niobium compounds, and for the identification of the two elements in admixture, the colours of the respective precipitates being characteristic.

The Determination of Sulphates in Guncotton, by H. B. Dunnicliffe, M.A., D.Sc., F.I.C.

A modified method is described giving very accurate results when sodium chlorate at low concentrations is used as the oxidising agent. It is based on a series of experiments in which the conditions have been ascertained for complete oxidation of the highly-coloured substances in guncotton, while leaving the whole of the sulphur present in the form of soluble sulphates. Incomplete oxidation may be partly due to a low atmospheric pressure in the laboratory. There does not appear to be any direct relationship between the sulphate content and the organic matter insoluble in acetone.

The Reduction of Chloric Acid and Chlorates by Ferrous Sulphate, by C. O. HARVEY, B.Sc., A.R.C.S., A.I.C.

The results obtained by reducing chloric acid and chlorates with a neutral solution of ferrous sulphate are shown by gravimetric and volumetric determinations to be about 8 per cent. too low. Reduction in acid solution gives results about 1 per cent. below theory, and to obtain this degree of accuracy, the reduction must be carried out at 100° C. The reaction between potassium iodide and potassium chlorate in the presence of a sulphuric acid solution of ferrous sulphate has also been studied, and the conditions for a rapid volumetric determination of chloric acid (accurate to within about 0.8 per cent.) based on the reaction have been ascertained.

THE CHEMICAL SOCIETY.

Papers read on October 15.

The Effect of Ultra-violet Light on Dried Hydrogen and Oxygen, by H. B. BAKER AND MISS M. CARLTON.

The work of Cohen and Tramm indicated that a hydrogen and oxygen mixture dried so that no explosion took place but only slow combination on heating, would combine as readily in the dried as in the undried condition under the action of ultra-violet light.

The work has been repeated with six pairs of quartz tubes filled with the gaseous mixture produced by the electrolysis of very pure baryta, one of each pair containing some distilled phosphorus pentoxide. In every case, whether the drying lasted 8 weeks or 2 weeks there was a difference in the rate of union of the dried and the wet gases. After drying for 7 and 8 weeks, the gas gave no measurable contraction after exposure to the light from a quartz mercury lamp, the comparative wet tubes showing a considerable amount of union with the same exposure. No ozone was produced in either the wet or the dry gas.

A New Peroxide of Barium, by MISS M. CARLTON.

By the action of excess of hydrogen dioxide on an aqueous solution of baryta at a temperature below 20° C., a white substance is produced which turns buff-coloured on keeping. It liberates chlorine very freely from hydrochloric acid, and is decomposed by manganese dioxide and water with liberation of much oxygen. Bromine is liberated from potassium bromide on acidification with nitric or hydrofluoric acid.

On analysis the substance is shown not to contain hydrogen dioxide of crystallisation, but is a higher peroxide of barium having the formula BaO_4.

The Production of Oxide-films on Copper at Ordinary Temperatures, by U. R. EVANS.

Interference colours similar to those obtained by exposure to air at high temperatures can be obtained on copper at ordinary temperatures by cathodic treatment in $N/10$ sodium hydroxide followed by exposure to dissolved oxygen. The colouring power of the polarised cathode is destroyed by raising it into the air after electrolysis, or by wiping or vigorous stirring; but exposure to air *before* electrolysis favours coloration. The colouring power depends on the duration of electrolysis and on the supply of oxygen after electrolysis ceases. It is probably due to hydrogen stored in the copper, which permits of alternate oxidation and reduction; the oxide-layer, being to some extent kept porous, reaches a thickness capable of giving tints, even at temperatures too low to give tints in the absence of hydrogen.

Anodic treatment of copper in $N/10$ sodium hydroxide produces passivity at high current density, oxygen being evolved, but at high current density causes attack of the copper, which becomes covered with blackish velvety oxide; if the solution is stirred, bright colours appear on the anode. Copper partly immersed in $N/10$ sodium hydroxide, without externally applied E.M.F., becomes covered with the velvety black deposit at the unærated (anodic) places no doubt as the result of differential æration currents.

Copper which has been exposed to air probably as the result of an invisible oxide film is blackened more slowly by $N/25$ silver nitrate than freshly ground copper.

The Structural Isomerism of the Oximes. Part III. The Benzilmonoximes, by MRS. A. H. ATACK AND F. W. ATACK.

In Forster and Dunn's method for preparing α-benzilmonoxime, benzil dissolved in pyridine is treated with pyridine containing hydroxylamine obtained by decomposing hydroxylamine hydrochloride with powdered sodium hydroxide. The authors find that if the pyridine solution is obtained by decomposing hydroxylamine hydrochloride with sodium hydrogen carbonate

in presence of a limited amount of water, followed by addition of the pyridine, the isomeric β monoxime is obtained almost exclusively.

The authors conclude that two structural isomerides of hydroxylamine exist and yield two structurally isomeric oximes.

α-Benzilmonoxime gives a buff-coloured nickel compound, soluble in chloroform to a brown solution; β-benzilmonoxime does not give a nickel compound. Evidence has been obtained of the existence of a red nickel compound, soluble in chloroform to an intense red solution.

COMING EVENTS.

SOCIETY OF GLASS TECHNOLOGY.

ARRANGEMENTS FOR MEETINGS FOR THE SESSION, 1925-26.

1925.
November 21– Sheffield.
November 18 Leeds.
December 16 London.

1926.
January 20 Manchester.
February 17 Sheffield.
March 17 Stourbridge.
April 21 Sheffield (Annual General Meeting).
May 19 London.
June 16 Sheffield.

The meetings will, unless announced otherwise, commence at 2.30 p.m. Details of the Programme arranged will be announced a week prior to each meeting.

THE PHYSICAL SOCIETY OF LONDON AND THE OPTICAL SOCIETY.

Sixteenth annual exhibition of electrical, optical and other physical apparatus, Tuesday, Wednesday and Thursday, January 5, 6 and 7, 1926.

The Councils of the above Societies have decided to extend the scope of the Annual Exhibition by including, in addition to the usual display by Instrument Makers, the following new classes of exhibits :—

(*a*) Exhibits illustrating the results of recent physical research and improvements in laboratory practice.

(*b*) Selected examples of effective lecture experiments.

(*c*) Repetitions of famous historical experiments in physics.

Accommodation for these will be provided in a part of the Imperial College distinct from that devoted to the trade exhibits, and a section of the catalogue will be allotted to them.

No charge will be made for space or catalogue entries in the new classes, and the facilities of the Imperial College will be at the disposal of exhibitors.

Offers giving preliminary particulars should be addressed to the Secretary of the Physical Society at the Imperial College of Science, South Kensington, as early as possible, and not later than *November* 16.

CHEMISTRY.

LONDON PROGRAMME FOR SESSION 1925-26 OF ORDINARY MEETINGS OF CHEMICAL INTEREST.

Mon. 2 Nov.—Society of Chemical Industry (L.S.).
Wed. 4 ,, - Society of Public Analysts.
Thur. 5 ,, – Chemical Society.
Mon. 9 ,, -Biochemical Society.
Tues. 10 ,, - Institute of Petroleum Technologists.
Wed. 11 ,, —Institute of Chemical Engineers.
Thur. 12 ,, —Oil and Colour Chemists Association.
Fri. 13 ,, —British Chemistry Dinner.
Mon. 16 ,, —Faraday Society.
Wed. 18 ,, —Institute of Chemistry (L.S.).
Thur. 19 ,, —Chemical Society.
Mon. 23 ,, —Chemical Industry Club.

INSTITUTE OF CHEMISTRY.

(LONDON AND EASTERN COUNTIES SECTION.)

ANNUAL GENERAL MEETING.

The annual general meeting will be held on Wednesday, 18 November, and not on 19 November, as previously announced.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

23,647.—Bodrero, B.—Manufacture of sulphuro-phosphate. September 22nd.

23,869.—Bone, W. A. Production of activated nitrogen. September 24th.

23,057.—Ges fur Kohlentechnik.—Production of sodium bicarbonate and sal ammoniac. September 21st.

23,801.—Hatfield, H. S.—Chemical analysis. September 24th.

24,399.—Chemische Fabrik Griesheim-Elektron.—Production of iron-free alumina. September 30th.

24,618.—Long, C. L.—Manufacture of halogenohydrins. October 2nd.

24,366.—Pollack, F.—Treatment of condensation products of carbamide, etc., with aldehydes. September 30th.

24,436. Snedker, S. J. C. Production of aromatic thiocarbamides. October 1st.

Specifications Published this Week.

239,551.—Adelantado, L.—Manufacture of phosphate fertiliser.

231,801.—Lilienfeld, Dr. L. Manufacture of new cellulose compounds.

239,584.—Dorignac, F., and Bergeret, P.—Process for the preservation of organic or vegetable substances.

222,187.—Synthetic Ammonia and Nitrates, Ltd.—Synthetic ammonia process.

239,895.—Steffen, junr., C.—Process for the continuous washing of tricalcium saccharate.

219,649.—Soc. Chimiques des Usines du Rhone.—Catalysts proper for reduction and hydrogenation processes.

239,933.—Soc. of Chemical Industry in Basle.—Manufacture of new dyestuffs containing sulphur.

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222,463. Schicht Akt-Ges. G. Process for the preparation of phosphatides.

222,141. Austerweil, G. Process for the production of terpene alcohols.

223,601. Vidal, R. Preparation of fatty acids and their alkali combinations.

Abstract Published This Week.

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Carboxylic acids; aldehydes; ketones; catalytic agents, preparation of. The oxidation of alcohols and aldehydes to carboxylic acids, alhehydes and ketones is effected by leading a mixture of the alcohol or aldehyde vapour with an oxygen-containing gas over a heated metallic vanadate, other than a simple vanadate of an alkali metal. The vanadates of tin, bismuth, cobalt and lead are specifically mentioned. Thus, benzyl alcohol vapour with excess of air over heated tin vanadate (prepared by the interaction of ammonium vanadate and stannic chloride in aqueous solution) yields benzoic acid. Benzaldehyde under the same conditions gives benzoic acid, and ethyl alcohol a mixture of acetic acid and acetaldhyde.

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STOXAL.

455,611.—A chemical substance for the destruction of mosquito lavæ.—Les Etablissements Poulenc Freres, 86, Rue Vieille-du Temple, Paris. October 7th, 1925.

MORTEGG.

461,236. Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes, but not including poultry medicines, or goods of a like kind. Murphy and Son, Ltd., The Cedars, Sheen Lake, Mortlake, London, S.W.14. October 7th, 1925.

461,464. Ornamental Bottle device for chemical substances prepared for use in medicine and pharmacy. Foreign Chemists, Ltd., 15, Great Street, Andrew Street, London, W.C.2. October 7th, 1925.

461,334. Illustration of Forth Bridge bearing words RED BAND MAGNESIA for chemical preparations of Magnesia for use in medicine and pharmacy. Red Band Chemical Co., 15a, Richmond Terrace, Dalry Road, Edinburgh. October 7th, 1925.

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LATEST CANADIAN PATENTS.

253,605. Electric Water Heater (Chauffe-eau électrique.) Andrew Eathan Cowles, Kellogg, Idaho, U.S.A. 15 September, 1925. Filed 28 April, 1925. Serial No. 302,156.

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SEARCH FOR THE ELEMENT 93.

By J. G. F. DRUCE, M.Sc. (Lond.), R.Nat.Dr. (Prague).

Part I.

EXAMINATION OF CRUDE MANGANESE COMPOUNDS AND THE ISOLATION OF ELEMENT OF ATOMIC NUMBER 75.

Introduction.

F. H. Loring suggested this research, and lent assistance in the physical part, which I have the pleasure of acknowledging in the text.

It will be remembered Bohr[1] suggested that the atomic numbers of the inert gases might extend to 118, but from radioactive considerations those elements above atomic number 92 may be too unstable to have had a permanent existence.

However this may be, one of us has developed a system of "B" numbers which were derived principally from planetary and satellite distances[2]. It was concluded that these numbers should run: 3, 7, 9, 13, 21, 45, 119, 411, 795[3] These numbers from 3 to 119 inclusive can be connected with the atomic numbers of the inert elements in the manner according to Scheme I[3].

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CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

Although the scheme indicates an atomic number of 118 for an inert element next above the emanations of atomic number 86, agreeing with Bohr's suggestion, it does not necessarily follow that there are elements beyond uranium of atomic number 92. In fact it was suggested by one of us[1] that the limit might be 93, because in a set of elements apparently existing in minute quantities relative to their next-door neighbours in the atomic-number sequence or in some cases possibly not existing at all they were marked off by a series of regular atomic-number differences, and this happened to correspond with the step-differences in the periodic classification when arranged in tabular form in longer and longer horizontal series[1]. Moreover, these differences formed a limiting number series. 93 stood at the higher limit, and scandium, 21, stood at the lower limit, and it is well-known that scandium exists in very small quantities relative to calcium and titanium on each side of it. Another reason was that the B numbers up to 45 were systematically representative of certain natural groupings in the periodic table[3 5]. The "whys" and "wherefores"

Scheme I.

B No. Series.		At No	Inert Gas.
$(3\times1)-1^2$	=	2	He
$(7\times2)-2^2$	=	10	Ne
$(9\times3)-3^2$	=	18	Ar
$(13\times4)-4^2$	=	36	Kr
$(21\times3)-3^2$	=	54	Xe
$(45\times2)-2^2$	=	86	Rn
$(119\times1)-1^2$	=	118	

USING THE WELL-KNOWN SERIES FOR CALCULATING THE ATOMIC NUMBERS OF THE INERT GASES AND COMBINING WITH IT THE SERIES $n = 1, 2, 3, 4, 3, 2, 1$, THEN BY STOPPING OFF TERMS THE B NUMBERS CAN BE CALCULATED THUS—

$$\frac{\left[2\times(1^2+2^2+2^2+3^2+3^2+4^2+4^2)\right]+n^2}{n} = \text{B Nos.}$$

THEREFORE $Bn - n^2 = \text{At. No.}$

of number relations are often obscure, but we might say in general, with de Chancourtois, that the "properties of the elements are the properties of numbers."[6] Siegbahn[7] shows a Mendeleeff type of table containing "93" as the last element therein, it being, of course, in Group VII. along with those elements of atomic numbers 43, 61, 75; but 61 more properly belongs to the rare-earth series of 13 elements Pr to Lu inclusive. Cerium, by the way, seems to fit fairly well into Group IV., and it may be mentioned that the cerium hydride, supposed to be CeH_3, is now being investigated, as evidence has been adduced that it may be a mixture of hydrides CeH_4 and Ce_2H_5. Hafnium (celtium) also comes into Group IV., but on a displaced wedge, according to a solid figure scheme of one of us[1]. This displacement seems in some way due to the 13 elements here mentioned.

When Noddack and Tacke[9] published their discovery of elements of atomic numbers 43 and 75, which were found in small quantities, they had drawn up as a guiding scheme a table showing a minimum quantity in each series at 43 and 75. This drop, though only roughly evaluated, is on the same lines as developed by one of us[1] in respect of these elements. Their table is reproduced here as Table I.

Table I.

Sc	Ti $2\cdot10^{-3}$	V $3\cdot10^{-5}$	Cr $3\cdot10^{-6}$	Mn $7\cdot10^{-5}$	Fe 10^{-3}	Co $3\cdot10^{-5}$	Ni $3\cdot10^{-5}$	Cu 10^{-7}	Zn 10^{-6}	Ga 10^{-9}	Ge	As 10^{-7}
Y $2\cdot10^{-4}$	Zr $6\cdot10^{-6}$	Nb 10^{-7}	Mo 10^{-7}	43 $\sim10^{-12}$	Ru $2\cdot10^{-11}$	Rh 10^{-11}	Pd 10^{-11}	Ag 10^{-9}	Cd 10^{-8}	In 10^{-9}	Sn $7\cdot10^{-8}$	Sb $7\cdot10^{-8}$
La $6\cdot10^{-7}$	Hf $6\cdot10^{-8}$	Ta $5\cdot10^{-7}$	W $5\cdot10^{-7}$	75 $\sim10^{-12}$	Os $2\cdot10^{-11}$	Ir $2\cdot10^{-11}$	Pt 10^{-9}	Au 10^{-9}	Hg 10^{-9}	Tl $4\cdot10^{-9}$	Pb $4\cdot10^{-7}$	Bi 10^{-9}
	Th $7\cdot10^{-8}$		U $7\cdot10^{-8}$									

It was noticed that these investigators obtained in their final products one-half per cent. of element 43 and five per cent. of element 75. This led one of us to consider as a possibility that if element 93 existed it might follow the upward rise from 43 to 75 and exist in quantities even greater than 75. Of course, the converse view may be true, but in that case it might not be quantitatively less than 43.

Prior to this investigation, Bosanquet and Keeley[10] had subjected a number of minerals to cathode-ray bombardment, hoping to get the X-ray lines of one or more of the missing elements of the manganese group. Among several minerals, they tried pyrolusite, but not one of the minerals investigated in this way gave any sign of a new element being present. This might be expected if one or more of the elements were present in very small amount.

An earlier investigation along chemical lines, referred to in the next section, led to no results, but attention was directed to certain difficulties in preparing pure manganese chloride from residues obtained in making chlorine by the action of hydrochloric acid upon pyrolusite. This work has indirectly proved to be a valuable clue, as will appear later.

With the above findings, both positive and negative, and bearing the numerical relationships interwoven with them in mind, we concluded that it would be worth while making a systematic search for element 93. Also to look for any elements immediately beyond 93 as they might follow the iron group (VIII.) in having somewhat similar characteristics which new methods of analysis might bring to light.

Chemical Investigations. The preparation of a sample of the oxide of the element number 75 is the outcome of an investigation upon the impurities in commercial manganese salts.

W. Smith[11], as indicated above, had directed attention to the difficulties attending the preparation of pure manganese chloride from residues used in making chlorine by the action of hydrochloric acid upon pyrolusite. Chemists are also well aware of the troublesome behaviour of manganese salts in the course of qualitative analysis. This has usually been ascribed to the presence of iron and calcium which the commercial salts frequently contain.

The announcement by Noddack and Tacke[9] of the discovery of eka- and dvi-manganese of atomic numbers 43 and 75 respectively, in certain minerals following on the studies of one of us outlined above, caused us to undertake the investigation of

the impurities in commercial manganese sulphate, to see if this contained a higher "homologue" of manganese, particularly the element 93.

Noddack and Tacke state that they found traces of 43 and 75 in certain platinum and columbite ores. They were able to obtain a final product which contained, according to their estimate, 0.5% of element 43, and 5% of element 75. We have been able to obtain a mixture of oxides much richer in 75 although it appears to contain no 43 .

Our first efforts were made with the view to fractional crystallisation of about 100 grams of manganese sulphate, but this was abandoned in favour of a method of precipitation.

According to Noddack and Tacke[9] the sulphides of 43 and 75 should not be formed in water like that of chromium. This suggested a means of separating 75 from manganese, which was effected as follows

100 grams of the crude sulphate were dissolved in 600 c.c. of water together with 50 grams of ammonium chloride; 25 c.c. of .880 ammonia were added and hydrogen sulphide gas was passed in for some time. The mixture, saturated with the gas, was allowed to stand some hours before filtration. The precipitate should have included iron sulphide and any aluminium or chromium hydroxides. The filtrate was retreated with hydrogen sulphide until there was no further precipitation. This required several filtrations before a solution was obtained which no longer gave any precipitate when saturated with the gas and allowed to stand. The filtrate and washings were allowed to stand for several days whilst still alkaline with ammonia and saturated with hydrogen sulphide to make quite sure that all manganese had been removed. The solution was afterwards boiled for some minutes to remove excess of hydrogen sulphide and some ammonia, acidified with hydrochloric acid and evaporated to dryness. The residue was strongly heated to drive off the ammonium compounds and burn away the small quantity of sulphur formed. The final residue was dissolved in acetic acid and ammonium oxalate in slight excess was added to precipitate the calcium present. The filtrate was evaporated to dryness and ignited strongly to drive off all ammonium compounds. The residue was dissolved in hot dilute nitric acid.

The solution was precipitated with ammonium hydroxide and the washed precipitate was dissolved in hot dilute nitric acid and evaporated to dryness again, leaving a white nitrate which was ignited to a very light brown oxide. In this way 75 milligrams of the still impure oxide were obtained.

The oxide was soluble in dilute mineral acids on warming, giving colourless solutions, except the chloride which was slightly yellow. Solutions of the caustic alkalis precipitated the hydroxide of the element, which was insoluble in excess.

Another quantity of crude manganese sulphate was worked up in accordance with the method of Noddack and Tacke, but the yield of mixed oxides was very small. It may be noted that the discoverers have named the element, of atomic number 75, rhenium (Re), which name we propose to use in the future.

Investigations are now proceeding with a view of ascertaining if a new element can be obtained from pyrolusite, and will appear in Part II. In using the word "new" we mean new to experience.

Fresh quantities of the oxide are also being prepared for a further study of the chemical properties of rhenium and its salts.

Physical Investigations. Having prepared the oxide as indicated above, we proceeded to examine the spectrum by a well-known X-ray method giving the X-ray lines. Messrs. Adam Hilger, Ltd., kindly agreed to take, in their research laboratory, a series of spectrograms. The result is as follows: -

The sample, in the form of an oxide, was expected to contain one or more elements having atomic numbers 43, 61, 75, 93, together with Fe, Mn, and Ca, known to be present as impurities. 61 was hardly expected to be present, but it was included in the list.

The method employed consisted in exciting the characteristic X-radiations of the elements present in the sample, spreading these into a spectrum by the Bragg method of reflection at a crystal plane, and recording the lines photographically. For this purpose, the sample, in coarse powder form, was pressed on a roughened copper anticathode of a Shearer pattern X-ray tube. This was run at 8 to 10 milliamperes at a pressure of about 60,000 volts. The spectrum was obtained with a Muller X-ray spectrograph, using a rocksalt crystal.

In a preliminary run, exposures of three

hours each were made with the crystal oscillating between 0° and 15′, and 15 and 30° respectively, for the glancing angle of the incident X-ray beam. These exposures gave no lines on the film other than those due to the $K\alpha$ and $K\beta$ characteristic radiations of copper. This indicates that neither of the elements 43 or 61 was present in the sample, for their characteristic K radiations would have wave-lengths approximately 0.67A and 0.32A, which would be reflected strongly for glancing angles 6°30′ to 7°, and 3° to 30° respectively.

The region 15° to 25° was next explored, giving an exposure of 6 hours with a view to obtaining the L radiation for one or two of elements 61, 75, 93, if present. This exposure gave lines which could be identified, to within one-half of one per cent., with $MnK\alpha$, $FeK\alpha$, $MnK\beta$, $FeK\beta$ $CuK\alpha$, λ = 1.43A, $CuK\beta$.

λ = 1.43A was determined by measuring its distance from the $CuK\beta$ line, since both lines were fine and clear cut. This fineness is presumably due to the oscillation of the crystal being just sufficient to give the requisite glancing angle for the reflection of these wave-lengths. λ = 1.43A corresponds almost exactly with the value obtained by Berg and Tacke[14] for the most intense L line of the element 75.

The crystal was next oscillated between 11° and 16° glancing angle, approximately, with an exposure of 6 hours. This oscillation covers the range 1.1A to 1.6A very approximately, in which region the complete L radiation of element 75 was found by Berg and Tacke[12], as would be expected from the Moseley law. The negative obtained shows lines agreeing closely with the following :— $CuK\alpha$, $75L\alpha$, $CuK\beta$, λ = 1.283, a shadow edge λ = 1.125A.

λ = 1.283A is almost exactly the wavelength for the strongest line in the $L\beta$ group of element 75, as measured by Berg and Tacke.

λ = 1.125 does not fit any characteristic radiation to be expected, and it appears to be a shadow edge rather than a line, since its intensity is least on the short wavelength side corresponding to a glancing angle of 11° 30′ approximately. It is probably due to the limit of the angle of oscillation.

No trace was found of a line corresponding to the characteristic radiations to be expected from an element 93. The wavelengths would be of the order of $K\alpha$ = 0.1A, $L\alpha$ = 0.88A, M = 3.5A with corresponding glancing angles for rocksalt of about 1°, 9, 38 to 39. The first would most probably be obliterated by the central beam if sufficient voltage were available for its excitation, while the M radiation would need to be investigated with a vacuum spectrograph. We are, with present arrangements, limited to the L radiation in the case of 93, but no pronounced line of the L series of this element was obtained on any of the exposures given. Some very faint lines appeared on the films, which might correspond with the α radiations of several well-known elements present in very minute quantity. A line, possibly corresponding to $85L\alpha$, was just barely visible, but this must be regarded as inconclusive evidence.

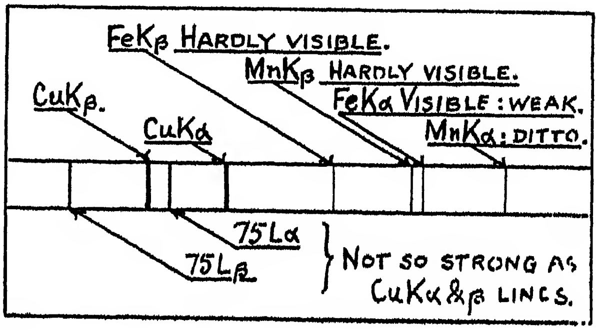

Fig. I.

Referring to Fig. I., this is reproduced from a drawing which shows on proportionate scale the various lines that appeared on the films which could be identified. Some of the lines were too faint to reproduce in printing, so recourse to a drawing was necessary.

This investigation indicates that the element 75 was present in sufficient quantity to yield fairly strong lines, and therefore indicating an appreciable amount of this element present, but no other new element was definitely detected. It should be noted that the atomic numbers of copper (29) and rhenium (75) differ too much from each other to make it possible to form an opinion as to the quantity of the latter present in the sample by comparing their respective lines, assuming that other conditions which have to be taken into account, were practically the same.

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IS RADIATION DIRECTED QUANTA?

The photo-electric effect, in which electrons fly out of a clean metal surface at a certain fixed velocity regardless of the intensity of the illumination, was formulated by Einstein, who regarded the illumating light as light made up of quanta, which would indeed account for the invariable velocity if one quantum drives out one electron with a given amount of energy nothing more nothing less, with a given metal and a given light frequency. Einstein's equation, however, did not of necessity involve so radical a theory of light as the equation might fit some other theory equally well. The undulatory theory accounts so completely for interference phenomena that to give it up on account of the photo-electric effect was at the time quite out of the question.

A considerable mass of experimental evidence in favour of a directed quantum theory of light has in the meantime accumulated. Newton was, perhaps, the very first to suggest a corpuscular theory of light, but the undulatory theory was so satisfactory in dealing with all manner of optical phenomena that Newton's theory never gained acceptance. In fact, it was never properly developed as a complete theory.

The use of the quantum conception of Max Planck in building up the atom, the accomplishment of Rutherford and Bohr, particularly the latter, has directed attention to the study of quantum relations in several kinds of radiation phenomena, especially in X-ray work and the analysis of spectrum lines.

A. H. Compton and A. W. Simon in the *Physical Review* for September, 1925, describe X-ray experiments that point almost conclusively to the quantum theory of X-ray radiation. Now X-rays are thought to be the same as ordinary light but having a very short wave-length, of atomic dimensions; and at the other extreme of the spectrum the Hertz waves used in wireless are thought to be light waves on a very large scale of wave-length. The extreme frequencies are also at the two corresponding wave extremes in these two cases, obviously. The reasons are very strong for a certain type of action, though specific differences are apparent when comparing extremes.

If, therefore, X-rays are directed quanta, then all light may be the same in principle just as all radiation is in principle electro magnetic radiation. The above physicists say that they have evidence which "seems a direct and conclusive proof that at least a large proportion of the scattered X-rays proceed in directed quanta of radiant energy." If true, this is an epoch-making discovery. Attention, however, should be drawn to an experiment by Bothe and Geiger (*Naturwissenschaften*, May 15, 1925; see *Zeit.f.Physik.*, 1925, vol. 32, p. 639) which points in the same direction. The corpuscular conception of radiation has been mooted for a long time. As far back as ten years ago the writer gave expression to the following ideas in this Journal (1915, CXI., p. 301), similar ideas being current at the time.

Discussing *mass* and *weight*, it was stated that the latter "is difficult to reconcile with electromagnetic mass, or mass existing without weight (?). This might constitute electromagnetic mass, if we consider the β-particle (negative electron) as having electromagnetic mass, and the γ-particle (X-ray) as a β-particle which had lost its electromagnetic mass entirely, and gained a corresponding amount of weight-mass. Are we not here dealing with a *material* end of the spectrum?" The "reconciliation" above referred to, was the mass as defined in the equation : weight equals mass

multiplied by acceleration of gravity. In a foot-note the following appeared (same citation):— "The light rays may be vortex-rings of energy (atoms) which alternately thread through each other, expanding and contracting, thus giving rise to a periodic phenomena that may be treated as an electromagnetic wave motion of an all-pervading ætheric medium, which in reality does not perhaps exist as such. It is as if we could take the long drawn-out lines of magnetism of a magnet or coil and weave them into a fabric comprising minute closed-up vortex-coils; then, as this fabric is manufactured at the light source and hurled out broadside on, its coils undergo a sort of Brownian movement in threading through each other, expanding and contracting in the process."

In the Compton-Simon experiment, mentioned above, a beam of filtered X-rays was directed into an expansion chamber containing air where there were a number of diaphragms of lead foil which became a source of electrons or β-rays by reason of the photo-electric effect. The Wilson cloud method was employed and the β-ray tracks photographed by a very intense light obtained by exploding electrically tungsten wires. Nearly 1,300 stereoscopic cloud-expansion photographs were taken. "If the quantum of scattered X-rays produces a β-ray in the chamber, then a line drawn from the beginning of the recoil track to the beginning of the β-track gives the direction of the ray after scattering." Theory indicated that if the angle fell within a certain range, 20°, then the energy of momentum of the quantum is conserved "during the interaction between the radiation and the recoil electron." This indicated an absence of spherical spreading of the X-ray radiation quantum so that the conclusion was that the radiation was emitted as quanta, for a sufficient number of photographic records fulfilling this condition were obtained.

In the concluding part of the paper the authors say: - "Since the only known effect of X-rays is the production of β-rays, and since the meaning of energy is the ability to produce an effect, our result means that there is scattered X-ray energy associated with each of these recoil electrons sufficient to produce a β-ray and proceeding in a direction determined at the moment of ejection of the recoil electron. In other words, at least a large part of the *scattered X-ray proceed in directed quanta of radiant energy*. Since other experiments have shown that these scattered X-rays can be diffracted by crystals, and are thus subject to the usual laws of interference, there is no reason to suppose that other forms of radiant energy possess an essentially different structure. It thus becomes highly probable that all electromagnetic radiation is constituted of discrete quanta proceeding in definite directions. It is not impossible to express this result in terms of waves if we suppose that a wave train possessing a single quantum of energy can produce an effect only in a certain predetermined direction." These results are "in direct support of the view that *energy and momentum are conserved during the interaction between radiation and individual electrons.*"

The experiment here reveiwed was suggested by W. F. G. Swann.

Those who believe in the æther and expanding waves of radiation therein will find the views as here supported by experiment very difficult to comprehend.

Of interest in this connection is the Compton effect in which γ-radiation, or X-rays, falling on matter comes away in all directions as scattered radiation, with this peculiarity, however, that the scattered radiation is "softer," and this probably means than an increase in wave length has taken place.

In conclusion, one might raise the question, Are we so far from the understanding of the true mechanism of radiation that two widely differing theories can fit two sets of facts (as at present described) without error? F. H. L.

THE RELATION BETWEEN HEATING VALUE OF GAS AND ITS USEFULNESS TO THE CONSUMER.

A Critical Review of the Published Data.

By E. R. Weaver.

(*Chemist, U.S.A. Bureau of Standards.*)

[This pamphlet deserves a prominent place among the many useful technological papers issued by the Bureau of Standards. It takes a comprehensive view of the subject, giving valuable data obtained by various investigators. The following abstract and summary give the salient features of this valuable paper. Ed., *C. N.*]

The introduction, Section I., contains a description of the sources and a discussion of the character of the available information

which has an important bearing upon the subject treated. The data are divided into two classes, (1) direct observations of the useful effects obtained from the utilisation of gases of different qualities in the appliances in common use, and (2) statistical data showing changes in the quantity of gas used which accompanies changes in heating value.

Section II. contains a summary and some discussion of the data of the first class. Because of the large amount of such material only the briefest summary of such information consistent with clearness has been given. In some cases in which data are not available to the public in published form, and in others in which the reviewer does not agree with the authors upon the interpretation of the data, detailed figures are presented.

Section III. contains a summary and discussion of the general significance of the information presented in Section II. There is very general agreement that in all kinds of commercial appliances the potential heat of the gas is used with substantial equal efficiency, whatever the other properties of the gas may be. An explanation is offered for the general applicability of this relation to the results observed with appliances of the most varied character when using gases of any composition within the ordinary limits of commercial supply.

Section IV. presents the statistical data bearing upon the subject. It is found that within the limits which could be expected, in view of the numerous conditions which affect the volume of gas used by a community, this volume is inversely proportional to the heating value of the gas supplied. In other words, the amount of heat used by a community in the form of gas does not appear to be affected by the heating value of the supply.

Section V. contains a discussion of the statistical data in general and points out the application of the facts established to standards and rates.

Summary.

This paper contains a critical review of available data regarding the relative usefulness of gases of different heating value. The sources of material have been limited to published data, official reports, and dence to National, State, or municipal material which has been submitted as evibodies in connection with hearings on rates or standards.

This review has been confined almost exfigures; scant attention has been given to opinions and practically none to theory. clusively to facts expressed in definite In several cases, it is true, only the brief conclusions drawn from masses of data are given, usually in the author's own words. This has been necessary to keep the length of the review within reasonable limits. Full references are given which permit anyone sufficiently interested to verify the correctness of all the data and conclusions.

The available data have been divided into two classes: (1) The direct determination of the useful effects actually obtained by burning gas in various appliances, and (2) statistics regarding the relative amount of gas used before and after changes of heating value.

The data in the second group have been treated in various ways to eliminate disturbing factors so far as possible and to bring out any relationship which exists between heating value and consumption.

With the exception of one or two minor investigations containing only a few observations each, the data of the first class are in remarkable accord and show definitely that for any of the common uses of gas the same amount of potential heat is equally useful regardless of the volume, composition, or other properties of the gas in which the potential heat is conveyed. The reviewer has attempted an explanation for this general relation in section 8 of the paper.

The data of the second class are also surprisingly consistent, considering the number and variety of other influences to which they are subject. They show definitely that the volume of gas consumed by a community under conditions otherwise reasonably constant is substantially inversely proportional to the heating value; or, what amounts to the same thing, that the amount of heat used by the community is not affected materially by a change of heating value of the gas supplied. The two classes of data thus lead to the same conclusion--that the usefulness to the consumer of a given amount of gas is accurately proportional to its heating value. The important consequences of this conclusion as applied to rates and standards are pointed out in the last section of the review.

General Notes.

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Pass List.

Examination for the Associateship in General Chemistry.

Chater, Trevor Walter James (Central Technical School, Leeds); Everett, John Garwood (Chelsea Polytechnic); Hodgson, William Ronald Penrose, B.Sc. (Lond.) (University College, Exeter); Klein, Ralph Harry (Sir John Cass Technical Institute); Phillips, Montague Alexander (Battersea Polytechnic); Richards, Colbert Eric (Northern Polytechnic; and Sir John Cass Technical Institute); Richardson, Robert William (Central Technical School, Leeds); Vickers, Arthur Eric Jarvis, B.Sc. (Lond.) (Trained under the Head of the Chemistry Department, Central Schools of Science and Technology, Stoke-on-Trent).

In Branch (e) The Chemistry (including Microscopy) of Food and Drugs and of Water.

Williams, Albert Lester.

Examination for the Fellowship.

In Branch A: Inorganic Chemistry, Section II., Metallurgy.

Walker, William James.

In Branch E: The Chemistry (including Microscopy) of Food and Drugs and of Water.

Illing, Edward Thomas.

FUEL RESEARCH.

The Department of Scientific and Industrial Research has been empowered by the Government to make tests at the public expense of plants for the low temperature carbonisation of bituminous coal.

The object of these tests is to place, in the hands of those interested, accurate technical data on the quality and quantity of yields, the throughput of the plant, the working temperatures, and the general ease of working, together with such other information as it may be possible to obtain under the limited conditions of the tests.

A report has been issued dealing with a test of two retorts of Midland Coal Products, Ltd., erected at Netherfield, near Nottingham. This plant is intended to utilise low grade slack coal, which is briquetted before carbonising. The retort is internally heated, which results in a diminution of the solid fuel produced, as compared with externally heated retorts, and the production of a large quantity of gas of a low calorific value (about 200 B.Th.U. per cubic foot). While such a process is economical thermally, and should be economical also as regards capital and labour costs, it necessarily depends for commercial success on the existence of a market for the gas produced.

The conclusions that may be drawn from the report are as follows:

(1) The throughput and yields are approximately as claimed.

(2) The coke produced contains less volatile matter than ordinary "low temperature" coke and is not so free burning; it is very suitable for use in stoves, but not sufficiently free-burning for use in open grates unless these have a strong air draught.

(3) The plant showed certain defects, mainly in the auxiliary arrangements, which led to undue breakage of the briquettes and undue production of coke breeze. It is considered that there should be little difficulty in overcoming these defects.

The installation consisted of four retorts, each capable of a throughput of one ton of briquettes per hour. Two only of the four retorts were used for the purpose of the test.

The retorts strongly resemble blast furnaces in appearance, and are fully described together with the condensing plant. They are internally heated by the combustion of a part of the material under process of carbonisation.

It was intended to carbonise only 2½ oz. ovoid briquettes made in a Yeadon press at the Midland Coal Products premises from Nottingham Top Hard ½-in washed slack, using 8 per cent. medium hard coal tar pitch as a binder, but as barely 100 tons of these were available it was decided to carry on the test for three days by utilising a 5 oz. ovoid briquettes made from the same materials by the Butterley Coal Company at Kirkby.

During the test, samples of the briquettes and of the products of carbonisation were collected, working conditions were observed and the labour required noted. The

samples were brought to the Fuel Research Station for analysis.

The weight and heat balances do not give as valuable a criterion of the accuracy of the test as is usually the case, owing to the fact that the quantity of liquor produced was not measured, and that the quantity of air supplied was calculated from the nitrogen in the gas. The carbon balance, however, which shows a gain of 0.1 per cent. may be taken as an indication that the test was quite satisfactory.

The following are the yields of products per ton of briquettes carbonised:

Coke	...	7.5 cwt.
Gas	...	58,800 cu. ft., or 112.5 therms.
Tar	...	21 gallons.
Liquor	...	Calculated (about 42 gallons) from assay.

The coked material contains a remarkably small proportion of whole briquettes and a large proportion of breeze, the latter being of the order of 15 per cent. The larger pieces, i.e., ½-in to 1½-in. and over 1½-in. in size, are very hard, and stand transport very well. It contains about 2 per cent. volatile matter, and although unsuitable for the ordinary open household grate, is quite well suited for use in stoves.

The tar, the yield of which is high, is of a very viscid nature containing small proportions of the lighter oils, a large fraction between 270° and 360° C., and about 63 per cent. pitch.

The volume of gas produced is also large, and resembles a semi-water gas made from bituminous coal, has a calorific value of 193 B.Th.U. per cubic foot, and it the principal product of the process.

The ammonia liquor is so diluted in the Lymn washer that ammonia recovery is commercially impossible.

The temperature of carbonisation is of the order of 1,200° C., but the briquettes are subjected to the action of the hot gas for about two hours before reaching the hot combustion zone. A certain amount of low temperature distillation may take place but no appreciable amounts of unsaturated hydrocarbons or saturated hydrocarbons other than methane were detected on analysis of the gas, although they are always present in low temperature coal gases.

Details of the handling of the plant, of labour and power required are given.

CONCLUSIONS.

(*a*) The installation of four retorts is capable of carbonising 100 tons of briquettes per day of 24 hours.

(*b*) The process cannot be classified with low temperature carbonisation as generally understood.

(*c*) The briquetting of the slack was not satisfactory, as a large amount of broken material was left in the wagons, but this drawback could easily be obviated by more care in handling the hot briquettes, using air-dry coal and a more suitable briquette elevator.

(*d*) The temperature conditions could be controlled more satisfactorily by adjusting the steam supply and keeping the rate of charging and discharging constant.

The full report of this valuable test (which was carried out on January 20-23, 1925), has been issued in pamphlet form, and can be obtained from H.M. Publishing Office, Adastral House, Kingsway, London, W.C.2., price 9d.

PROGRESSIVE JAPAN.

The monthly *Trade Journal* of the British Chamber of Commerce in Turkey says that the Japanese Department of Communications has decided to allot 5,000 new telephones a year to the city of Osaka, beginning this year. This will entail the opening of an additional exchange yearly for several years. The Japanese telephones are of the automatic type. Much of the equipment required will be supplied by British manufacturers.

PLANT LIFE.

Recently, at Darjeeling, Sir J. Bose, the Indian scientist, gave particulars of some recent Indian discoveries in science. He pointed out that he has discovered that plants possess muscular tissue, and he showed how, contrary to all current theories, the mimosa plant possesses a highly-developed muscular system, which contracts when the plant is struck. Sir Jagadish Bose also demonstrated the effect of alcohol on plants, his chart showing first depression, and then exaltation, as with human beings. In the course of a lecture he declared that professors from all parts of the world have written to him asking to be enrolled as his students, in order to study the new methods which have had their birth in India.

CALCIUM CYANIDE.

The European producers of calcium cyanamide have formed an organisation to extend the use of this fertiliser in the principal agricultural countries of the world. The headquarters of the organisation are in London, and other offices are being opened in Belgium, Holland, India, Egypt, and other countries. Calcium cyanamide, which is produced by an electrical process from the nitrogen of the air, is already widely used as a fertiliser, being especially valuable for sugar beet and other root crops. The results of tests carried out in England have indicated that it is well suited to British soil conditions.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

BRITISH ASSOCIATION OF SCIENCE 1925 (SOUTHAMPTON) TRANSACTIONS.

[ABSTRACTS.]

PROF H. B. DIXON. *-Ignition of Gases.*

During the past three years experiments have been made for the Safety in Mines Research Board on the ignition of gases.

I. *Adiabatic Compression.* Mixtures of methane and air, and of hydrogen and oxygen, have been fired by rapid compression in steel cylinders by a piston which is stopped and held rigidly at any desired position in the cylinder. By trial there is found a compression which will just fire the mixture. With a rapid self-heating mixture (*e.g.*, electrolytic gas) the clamping position at the end of its stroke has a small but measurable effect; with a slow self-heating mixture (*e.g.*, methane and air) the clamping of the piston makes an important difference, since the gas during the period of self-heating has time to do work on the piston.

When oxygen is added to electrolytic gas, the ignition-point, as calculated from the compression, in continuously *lowered;* with methane-air mixtures the ignition-point is slightly reduced as the air is increased from 90.5 per cent. (the volume for complete combustion) to 98 per cent., after which the ignition-point rapidly rises.

II. *Concentric Tube Experiments.* When a stream of inflammable gas from a narrow central tube is made to enter an atmosphere of air or oxygen in a large cylinder, both gases being heated equally before meeting, the gas will ignite very rapidly (under 15 seconds) on escaping from the orifice so long as the temperature is maintained above a crucial point. On allowing the furnace to cool sufficiently, an appreciable time interval occurs between the turning on of the gas and its ignition. This gradually increasing "lag" is noted until the gas fails to ignite in 10 or 15 seconds. The cylinder is then slowly heated, and a series of diminishing lags is recorded, until the gas ignites again in less than .5 seconds. The *means* of the falling and rising temperatures observed at corresponding lags are taken as single readings.

A steel case has been made to contain the electric furnace and silica cylinder, so that ignitions may be observed both under increased and diminished pressure. An increase in pressure, as a rule, lowers the ignition-point of gases as indicated by theory; but in many cases, notably with hydrogen, a diminution in pressure down to one-tenth of an atmosphere causes a continuous lowering of the rapid ignition-point.

III. *Incipient Combustion.* Most gases show some visible signs of partial combustion before normal inflammation - notably methane. But the only gases with which we have been able to stabilise these incipient flames are mixtures containing carbon disulphide or ether.

PROF. W. T. DAVID. *Ignition of Gases.*

At Leeds we are working upon an apparatus in which spontaneous ignition temperatures of inflammable gaseous mixtures are determined by means of adiabatic compression produced by the flow of compressed air into a tube in which the inflammable mixtures are contained. Preliminary experiments with this apparatus show that the spontaneous ignition temperature varies with the pressure. For a 26.5 per cent. mixture of methane and oxygen, the following results were obtained :

Initial pressure of mixture (atmosphere)	.25	.5	.75	1.0
Minimum final pressure at which ignition took place (atmospheres)	10.25	13.2	15.75	21.0
Ignition temperature (°C)	475	400	370	355

Thus, in mixtures of methane and oxygen, the ignition temperature is decreased as the pressure is increased.

Experiments are being made upon the ignition temperatures of inflammable mixtures diluted with nitrogen and other gases, but they have not yet progressed sufficiently to enable me to give results.

It is possible that the experiments with nitrogen may yield results of great interest in view of experiments which, in conjunction with Messrs. S. G. Richardson and W. Davies, I have been making upon the effect of radiation on the rate of combustion of inflammable gaseous mixtures contained in a closed vessed. These experiments show that the introduction of infra-red radiation into the reacting system speeds up combustion provided

(i) that the radiation introduced is of the kind which can be absorbed by the combustible gas, and

(ii) that nitrogen is present in the gaseous mixtures.

Thus the rate of combustion of mixtures of CO and oxygen and nitrogen is speeded up by 1.4μ radiation (which is absorbed by CO), while that of mixtures of CH_4 and oxygen and nitrogen is speeded up by 3.2μ radiation (which is absorbed by CH_4). Hydrogen has no absorption bands, and it is found that the introduction of radiation does not affect the rate of combustion of mixtures of H_2 and air. No speeding up of combustion is found in any of these mixtures when the nitrogen is replaced by oxygen, argon, or CO_2.

Perhaps the most remarkable result obtained from the experiments is that different types of radiation produce the speeding up in the CH_4 and CO mixtures. Thus the effect of radiation is not due to the inhibiting of formation of oxides of nitrogen, for if this were the case, the same type of radiation should be effective, whatever the nature of the combustible gas. Rather the experiments suggest that some kind of temporary association between nitrogen and the combustible gas normally takes place during explosion, which association tends to be inhibited when the combustible gas is stimulated by radiation.

DR. O. C. DE C. ELLIS. *Notes on the Production of Flame in Closed Vessels.*

When ignition of a combustible mixture occurs in a closed vessel the rate at which the flame begins to spread is compounded of the rate at which the ignition is communicated from layer to layer of the mixture, and the rate at which the mixture just about to be burnt moves under the expansive force of the burning mixture. The rate at which the flame begins to spread away from the source of ignition is therefore but little different whether the vessel be virtually without walls (as with a soap-bubble) or closed, for the initial combustion takes place at constant pressure. This state of affairs persists in a closed vessels for only a very short time; then the existence of the enclosure manifests itself.

The first influence of the enclosure is on the direction of expansion of the burning gas, which is toward the more open space. If the enclosure has an opening in it the mean movement of the flame is toward that opening, and the flame will not travel through the remoter, completely enclosed part of the vessel until its other boundary has passed through the opening. In a strictly closed vessel the flame spreads from the region of ignition as if to reach all parts of the boundary at the same time. This is only a strong tendency ,however, and is not actually accomplished, except when ignition is central and the vessel spherical. It does not occur even then if the rate of spread of flame is so slow that convection currents can influence it. In such circumstances the flame-front travels upwards more quickly than downwards.

The second effect of the enclosure, very marked in small vessels, as the production of a second phase of slower propagation, following the first rapid spread of the flame. In the first phase we have slower propagation, assisted, in respect of spatial displacement, by expansion; in the second, it is probable that propagation takes place against a slight recoil. In the first place the gas burning is of low density; in the second phase the gas is burning under higher and increasing pressure. It is the second phase which is indicated in a gas explosion by the fairly straight portion of the ascending line of the time-pressure curve.

The third effect of the enclosure, most marked in rich mixtures, takes place among the flame-products, and is noticeable as a glow, occupying the space where originally the flame passed during its first phase; that is to say, it begins near the point of ignition. It begins, moreover, well before the flame has completed its passage throughout the vessel, so that it is not an effect of cooling. A dark zone lies between

the flame-front and this glow at the core, suggesting that the glowing material comprises the products of combustion of the first phase and the dark zone those of the second.

As soon as the flame reaches the boundary of the vessel the dark zone must cool and therefore contract. For this reason, presumably, the glow now expands to fill the entire vessel. It may, and usually does, persist for a period many times as great as that necessary for the complete spread of the flame through the sphere. During this post-flame period its volume gradually grows less and its mass-centre rises.

These effects are not dependent on the presence of nitrogen, nor are they a manifestation of changes in the water-gas equilibrium. It can be assumed that with such a mixture as $CO+O_2+4CO$ the dissociation of carbon dioxide is very slight (*cf.* W. A. Bone, Proc. Roy. Soc., 1925, 108 A, 408), but this mixture (when saturated with water-vapour at 22° C.) exhibits the glow very markedly. The mixture $2CO+O_2+5CO$ gives an even denser afterglow of approximately the same duration, namely about thirteen times that of the flame period. With $2CO+O_2+6CO$ the duration is nearly five times that of the flame period, and with $2CO+O_2+7CO$, nearly three times. That the glow is a concomitant of dissociation is thus the least likely of the several explanations which may be advanced.

Comparable with the mixture $2CO+O_2+4CO$ already referred to experiments have been made with a saturation of water-marked, but it is strikingly less both in density and duration. This latter fact suggests a third explanation; that burning takes place in the mixture after the flame has passed through it. Certainly radiations that can affect a photographic plate occur after flame has travelled through the mixture. It is conceivable that these radiations are due to the subsequent burning of the combustible gas which has escaped the passage of the flame. Experiments to test the possibility of such 'residual burning' occuring are in progress. This work is being carried out for the Safety in Mines Research Board, under the direction of Dr. R. V. Wheeler.

(To be continued.)

THE DEVELOPMENT OF CHEMICALS.

The Committee on Industry and Trade met under the chairmanship of Sir Arthur Balfour at the Board of Trade offices.

Evidence on behalf of the Association of British Chemical Manufacturers was given by Mr. W. J. U. Woolcock, C.B.E., the general manager of the Association.

Mr. Woolcock dealt first with the general position in regard to heavy chemicals and tar products. He said that, speaking generally, in this main group, either because of the nature of the chemicals or the presence of the raw materials in this country, or the superior organisation of the methods of production, the manufacture of the chemicals and developed and remained in this country. With the aid of cheap fuel and other advantages, an early lead was obtained in their manufacture. Certain of the continental countries, and notably Germany, were reducing this lead in pre-war days, and it should be noted that while in this country these industries were mainly operated as independent manufactures, in Germany they were merely basic units in the larger undertakings.

In the production of alkali, the proximity of salt, limestone and coal, coupled with the genius and perseverance of the founders of the industry more than a century ago, enabled this country to secure a great advantage. Continuous progressive research and subsequent developments have maintained the position thus secured, both in markets at home and abroad.

The nature of sulphuric acid precludes a large volume of export or import. The production in this country is, therefore, mainly for home consumption, and there is little to fear from outside competition in the sale of acid as such. In the case of secondary products in which acid is a primary raw material, foreign competition is of the first importance and has already gone far to kill the British superphosphate industry. In the manufacture of the acid, the cost of the raw material, whether spent oxide, pyrites or sulphur, and the efficiency of the plants and the consequent cost of production are of vital interest to other branches of chemical industry in which sulphuric acid is a fundamental raw material.

This country was the first to develop the production of coal tar on the large scale, and for many years was unchallenged in this field. Large quantities of primary tar products were exported, because the home

demand for the refined products did not develop at as great a rate as in continental countries which were building up their dye stuffs industries. The British products of primary tar products were at first dependent on the gas industry for their raw material. The recovery of the bye-products from coke ovens has, however, led to increases in the world production of tar, particularly in those continental countries where the manufacture of steel has developed rapidly. In all countries, the normal practice is for the tar products industry to operate as a separate branch of chemical industry.

Dealing with dyestuffs, intermediates and fine chemicals, Mr. Woolcock said that the distinguishing features of the chemicals in this group are the enormous number of the different products, the comparatively small quantities in which most of them are made, their relatively high cost of production, and the great degree of scientific skill required for their manufacture. They also differ materially from the other group in that the attempt has been made to maintain their production in this country by two digerent methods of protection now in operation. He then dealt with the three methods of protection which had been tried subsidy; total prohibition of imports except under licence; and Customs duties.

With regard to the Dyestuffs Act, the witness said that the machinery set up by the Act has worked quite well, mainly because there is on the side of the users of dyestuffs a very efficient Colour Users' Association. It was when the products which it was desired to protect were used by a great number of unorganised concerns that the method of prohibition and licence was unlikely to fail.

The Safeguarding of Industries Act, 1921, adopted the method of protection by means of tariff. Here it was desired to protect a variety of scientific industries, the products of which went to an even greater variety of consumers.

Mr. Woolcock claimed that after three years' working, it has been proved that Part I. of the Act (relating to key industries) has been useful in establishing in this country the fine chemical industry.

Mr. Woolcock dealt also with the general question of foreign competition, and the main causes which make such competition formidable; the export trade in chemicals and the special difficulties encountered in various markets; the serious effect on the home industry of the prevailing heavy local rates and high taxation; the efficiency and cost of transport as affecting the chemical industry; and the position and functions of merchants.

In conclusion he gave two or three interesting examples of the improvement and development of processes which have taken place, particularly in the fine chemical and dyestuffs sections of the industry. In this connection he referred particularly to insulin, pure medicinal glucose, laboratory chemicals, alkaloids, and the production of anthraquinone dyestuffs in soluble form.

BRITISH INDUSTRIES FAIR.

Record Number of Applications for Space.

The eleventh British Industries Fair to be held in London and Birmingham from February 15 to 26 next year, promises already in many ways to be the most successful, interesting and representative Fair of the series. Although forms of application for space have been in the hands of potential exhibitors only a few days, over 100,000 square feet of space has already been applied for, and new applications are being received daily by the Secretary of the Fair. This exceptional demand is, no doubt, due to the fact that so many firms realise the advantage of exhibiting in a fair, on the advertising of which the Government has decided to expend the sum of £20,000 in a wide world publicity campaign. Further, the charge for space has been reduced this year at both London and Birmingham, the charge in London being 2s. 6d. per square foot.

ROYAL MICROSCOPICAL SOCIETY.

The section of the Society which has been formed to deal with the "Industrial Applications of the Microscope," and to assist in the development of Scientific Research in Britsh Industries, will hold its next meeting at 20, Hanover Square, London, W.1., on Wednesday, 28 October, 1925, at 7 for 7.30 p.m., when the following communications will be read :—

Dark-Ground Illumination for the Examination of Textile Fibres, by Dr. F. J. Brislee, D.Sc., F.I.C., F.R.M.S.

The Microscopical Structure of Paper Making Fibres in Relationship to their Manufacturing Properties, by Mr. J. F. Strachan, F.Inst.P., F.R.M.S.

COMING EVENTS.

CHEMISTRY.

LONDON PROGRAMME FOR SESSION 1925-26 OF ORDINARY MEETINGS OF CHEMICAL INTEREST.

Wed. 2 Dec.—Society of Public Analysts.
Thur. 3 „ —Chemical Society.
Mon. 7 „ Society of Chem. Industry (L.S.), and Inst. of Chemistry (L.S.).
Mon. 7 „ Biochemical Society.
Tues. 8 „ Institute of Petroleum Pechnologists.
Wed. 9 „ Institute of Chemical Engineers.
Thur. 10 „ Oil and Colour Chemists Association.
Thur. 17 „ Chemical Society. (Informal.)
Mon. 21 „ —Chemical Industry Club.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London, W.C.2.

ARRANGEMENTS FOR FIRST PART OF SESSION, 1925-1926.

Ordinary meetings of the Institution Thursdays, at 6 p.m. Light refreshments, 5.30 p.m.

1925.
5 Nov. P. DUNSHEATH, O.B.E., M.A., B.Sc. *Dielectric Problems in High-Voltage Cables.*
19 „ —T. CARTER *The Engineer: His Due and His Duty in Life.* (Lecture to be followed by a discussion.)
3 Dec. —PROF. S. P. SMITH, D.Sc. —*An Electric House.*
17 „ — C. E. WEBB, B.Sc. (Eng.) *The Power Losses in Magnetic Sheet Material at High Flux Densities.*

Physics in Agriculture. The ninth lecture of the series "Physics in Industry," being given under the auspices of the Institute of Physics, will be delevered by DR. B. A. KEEN, Assistant Director of the Rothamsted Experimental Station, and it will deal with "The Physicist in Agriculture, with Special Reference to Soil Problems." The lecture, which will be open to the public, will be given in the Rooms of the Chemical Society, Burlington House, London, on Wednesday, November 25, at 5.30, and the chair will be taken by Sir William Bragg, President of the Institute.

ROYAL INSTITUTION.

21, Albemarle street, W.1.

General meeting of the Members, Monday, November 2, 1925, at 5 p.m.

CHELSEA POLYTECHNIC.

(Chemical Department.)

Manresa Road, London, S.W.3.

A series of four advanced lectures on Metal Crystals, by Professor H. C. H. Carpenter, F.R.S., will be given in the Department of Chemistry and Metallurgy of the Chelsea Polytechnic, S.W., on each Thursday in November, at 8 p.m., commencing November 5, next.

The lectures will embody the recent researches of Professor Carpenter and others on this subject, and will prove of special interest to those engaged in the metal industries, students of chemistry and physics and others.

ROYAL SOCIETY OF ARTS.

172nd SESSION, 1925-26.

The 172nd Session will be opened on Wednesday, November 4, at 8.30 p.m., when the inaugural address will be delivered by Sir Thomas H. Holland, K.C.S.I., K.C.I.E., F.R.S., Chairman of the Council, the subject being "The Organisation of Scientific Research throughout the Empire." The following week Sir Cecil Harcourt-Smith, C.V.O., will deliver the Trueman Wood Lecture on "The Modern Note in Industrial Art," the Earl of Crawford and Balcarres presiding.

MINERALOGICAL SOCIETY.

Anniversary meeting, Tuesday, November 3, at 5.30.

C. S. GARNETT *The Dissociation of Dolomite.*

B. J. TULLY *A New Refractometer.*

G. T. PRIOR *The Meteoric Iron of Vaalbult Farm, Prieska Division, Cape Province,* and *Meteoric Stone of Witklip, Carolina District, Transvaal.*

NOTICES OF BOOKS.

International Review of the Science and Practice of Agriculture.

The July-September issue, 300 pp., price 4s., is an encyclopædic review of agriculture and kindred subjects. The review is published four times per year in English, French, Italian, Spanish and German. Price 15s. for the year, or 4s. per copy. It is a valuable work for all interested in agriculture. International Institute of Agriculture, Rome.

New Patents.

This list is specially compiled for *The Chemical News*, by Rayner and Co., Regd. Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

25,018. Badische Anilin & Soda-Fabrik. Manufacture of condensation products and dyestuffs of the benzanthrone series. October 7th.

25,236. Badische Anilin & Soda-Fabrik. Manufacture of isodibenzanthrones. October 9th.

25,029. Dicker, S. G. D., Harter, H.—Catalytic synthesis of ammonia. October 7th.

24,928. Dewar, W. Metallurgical treatment of copper ores, etc. October 6th.

25,026. Downs, C. R. Distillation of bituminous materials. October 7th.

25,282. Metropolitan-Vickers Electrical Co., Ltd. Devices for chemical treatment of gases. October 9th.

Specifications Published this Week.

240,228. Cassella & Co., Ges L. Production of new arsenic acids.

220,651. Synthetic Ammonia & Nitrates, Ltd. Removal of carbon monoxide from gaseous mixture by means of cuprous solutions.

223,221. Riedel Akt.-Ges, J. D. Manufacture of barbituric acid derivatives.

236,146. Riedel Akt-Ges. J. D. Manufacture of barbituric acid derivatives.

225,821. Cederberg, Dr. I. W. Process for the catalytic combustion of ammonia-oxygen mixtures.

235,508. —Farbenfabriken Vorm. F. Bayer & Co.—Manufacture of new arylesters of nitro-amino sulphonic acids of the benzene series.

Messrs. Rayner and Co., will obtain printed copies of the Published Specifications only, and forward on post free for the price of 1/6 each.

The Latest TRADE MARKS

The following list of latest Trade Marks Published, is specially prepared for "*The Chemical News,*" by Messrs. Rayner and Co., Regd. Patent and Trade Mark Agents, of 5, Chancery Lane, London, who will give all information free regarding the Registration of British and Foreign Trade Marks.

RHODAMINTH.

460,605. Chemical substances prepared for use in medicine and pharmacy. Rhenania Verein Chemischer Fabriken Actien-Gesellschaft, 33, Kaiser Wilhelm Ring, Cologne, Germany. October 14th, 1925.

INTUBINE.

461,808. Chemical substances prepared for use in medicine and pharmacy. —Mikael Mandy Mandinian, 32, Edith Rd., Baron's Court, London, W.14. October 14th, 1925.

The above Marks have been "accepted" by H.M. Patent Office, and unless any objection is lodged, the Marks will be duly Registered. They are, however, officially advertised for opposition, which must be lodged within one month from date quoted. All particulars and forms for opposition will be sent free by Messrs. Rayner and Co., 5, Chancery Lane, London.

THE CHEMICAL NEWS,

VOLUME CXXXI. No. 3421.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

EKA-CAESIUM.

By F. H. LORING AND J. G. F. DRUCE.

Referring to our recent paper under the signature of one of us in this Journal (October 30, 1925, p. 278), on the isolation of crude rhenium oxide, it was noticed that a strange line appeared on one of the photographic films of the X-ray spectrum taken by Messrs. Adam Hilger, Ltd.

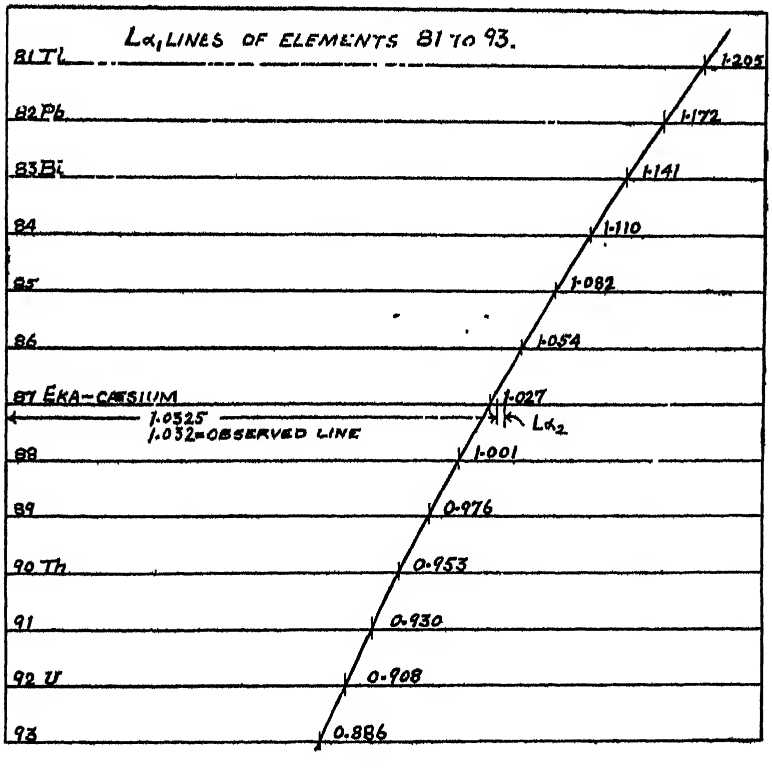
On investigation, we found that this line of wave-length 1.082A units, fell exactly between the theoretical $L\alpha_1$ and $L\alpha_2$ lines of element of atomic number 87. We looked for the $L\beta$ line for this element, but failed to find it, as the bromine-silver absorption bands on the film fell in the region where this line should appear as a very faint one. The resolving power of the spectrograph was not sufficient to show α_1 and α_2 lines separated appreciably. The measurement was therefore taken from the middle of the line using the α and β lines of copper on the film as standards for gauging the distance. The intensity of the line was only a little less than the $L\alpha$ line of rhenium, which appeared on the same film. There were no other lines except those of rhenium and copper; and without the oxide on the anti-cathode only copper lines appeared after running for six hours.

The evidence that the line is an α line of element of atomic number 87 is very strong, for in the immediate region of this line there are no other lines which would come out with the same intensity in all probability.

Referring to the accompanying curve, it will be seen that the fitting-in of this line is remarkably good, although we do not claim very high accuracy in the values obtained by means of the curve as shown, but they are well within the experimental error of the determination.

We have, for the present, designated the element *eka-caesium* in accordance with the nomenclature adopted by Mendeléeff. The existence of the highest and apparently the last homologue of the alkali-metal group (I.), is thus indicated.

Further work is being done to obtain this element, as free as possible, from other elements.



THE STRUCTURE OF CADMIUM.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The constitution of an atom of cadmium was given in *The Chemical News*, 1920, CXXI., 157, as Na_2Zn for chemical and mineralogical reasons. This constitution was also given in the same periodical in an advertisement on April 29, 1910.

It will now be proved to be correct quite independently by means of the laws of relative volume, heat of formation, and magnetic rotation.

TABLE I.

The Relative Volumes of Cd.

(1)	Cd(111)		Na(23)	+	Na(23)	+	Zn(65)
(2)	12.83		1.9	+	1.9	+	9.03
(3)	11.76		0	+	0	+	11.76
(3A)	13.66	=	0	+	1.9	+	11.76
(4)	15.56	=	1.9	+	1.9	+	11.76
(5)	14.73	=	0	+	0	+	14.73
(6)	19.59	=	0	+	0	+	19.59
(7)	15.16						

9.03, 11.76, 14.73 and 19.59 have previously been shown to be volumes of Zn. 1.9 (Na) has appeared many times as a constituent part of Cu, Se and Tl.

TABLE II.

Experimental Data Illustrating Table I.

	Relative Volume	Theor S.G. at 15° C.	Obs. S.G.	
(8)	Cd 12.83	8.655	8.655	11° Matthiessen
(9)	$SnCd_2$ 16.02 + 2(12.83)	8.16	8.189	11° Matthiessen
(10)	$SnCd_4$ 16.02 + 4(12.83)	8.34	8.336	14° Matthiessen
(11)	$SnCd_6$ 16.02 + 6(12.83)	8.43	8.432	15° Matthiessen
(12)	Sn 16.02	7.37	7.373	Deville
(13)	$PbCd_6$ 18.17 + 6(12.83)	9.16	9.160	13.7° Holzmann
(14)	Pb 18.17	11.34	11.340	Crichton
			11.33	Kupfer
(15)	$PbCd_4$ 18.17 + 4(12.83)	9.353	9.358	12° Holzmann
(16)	$PbCd_2$ 18.17 + 2(12.83)	9.76	9.755	15° Holzmann
(17)	Pb_6Cd 6(18.17) + 12.83	11.05	11.044	15° Holzmann
(18)	BiCd 21.29 + 12.83	9.38	9.388	15° Matthiessen
(19)	Bi 21.29	9.82	9.82	Roberts & W.
(20)	Bi_8Cd 8(21.29) + 12.83	9.785	9.787	14.7° Matthiessen
(21)	$BiCd_3$ 21.29 + 3(12.83)	9.07	9.078	13° Matthiessen
(22)	$CdAmCl_3$ 11.76 + 23.87 + 3(15.085)	2.912	2.93	Johnsen
(23)	CdF_2 11.76 + 2(5.42)	6.6	6.64	Nostrand
			5.992	22° Kebler
(24)	$Cd(OH)_2$ 11.76 + 4.45 + 2.51 + 2(5.76)	4.795	4.79	15° Schulten
(25)	CdI_2O_6 11.76 + 2(27.75) + 6(2.51)	5.600	5.644	Nostrand
(26)	CdI_2 11.76 + 25.24 + 27.75	5.637	5.622	5.66 Kebler
(27)	I (solid) 25.24	5.08	5.030	Playfair
(28)	$Am_2Cd(SO_4)_2.6H_2O$ 2(23.87) + 11.76 + 2(35.61) + 6(14.03)	2.08	2.073	Schiff
(29)	$CdCl_2$ 11.76 + 23.01 + 15.085	3.651	3.655	16.9° Knight
(30)	$BaCdBr_4 + 4H_2O$ 24.58 + 14.73 + 23.09 + 3(18.06) + 4(14.03)	3.70	3.687	Topsoe
(31)	$CdBr_2$ 14.73 + 23.09 + 18.06	4.85	4.712	4.91 14° Bodeker
(33)	$BaCdCl_4.4H_2O$ 23.98 + 14.73 + 4(15.085) + 4(14.03)	2.97	2.968	Topsoe
(34)	$K_2CdI_4.2H_2O$ 2(22.29) + 14.73 + 4(32.77) + 2(14.03)	3.357	3.359	Leonard
(35)	$CdCl_2$ 14.73 + 2(15.085)	4.05	4.05	25°/4 Nostrand
(36)	CdI_2 14.73 + 2(27.75)	5.2	5.543	Kebler
			4.576	10° Bodeker

(37)	$SrCd_2Cl_6.7H_2O$ 19.56 + 2(14.78) + 6(15.085) + 7(14.03)	2.78	2.708 i.e., 2.78 15°	24° Knight
(39)	CdSe 14.78 + 17.43	5.88	5.80	Margottet
			8.789	Little
(40)	$8(CdSO_4).8H_2O$ 8(14.73 + 30.59) + 8(14.03)	3.082	3.087	25°/4 Nostrand
(41)	$Cd(NO_3)_2.4H_2O$ 15.56 + 2(26.39) + 4(14.03)	2.467	2.46	20° Laws
(44)	CdS 15.56 + 15.53	4.60	4.605	Karsten
(45)	$CdS_2O_6.6H_2O$ 15.56 + 2(15.53) + 4(7.53) + 2(2.51) + 6(14.03)	2.28	2.272	Topsoe
(46)	CdI_2 19.59 + 32.77 + 27.75	4.56	4.576	10° Bodeker
(47)	CdS 19.59 + 10.51	4.75	4.80	Brooke
			4.605	Karsten
(48)	$CdCO_3$ 19.59 + 8 + 7.53 + 2(2.51)	4.260	4.258	Schroder
(49)	$CdC_2H_2O_4.2H_2O$ 19.59 + 2(23.8) + 2(14.03)	2.488	2.477	Schroder
(50)	$K_2Cd(SO_4)_2.6H_2O$ 2(18.05) + 19.59 + 2(30.59) + 6(14.03)	2.438	2.438	Schiff
(51)	CdO 15.16 + 2.51	7.19	8.11	Werther
			6.95	Karsten
(52)	CdSe 15.16 + 17.48	5.80	5.80	Margottet
(53)	Cd_4O 3(12.83) + 15.16 + 2.51	8.19	8.21 − 8.18	19° Nostrand
(54)	$MgCd(SO_4)_2.14H_2O$ 8.71 + 15.16 + 2(35.61) + 14(14.03)	1.986	1.988	Schiff
(55)	Am_4CdCl_6 4(23.87) + 13.66 + 6(15.085)	2.0	2.01	Johnsen

TABLE III.

	Heat of Formation of Cd.	Original Volume		Rel. Vol. in combination	Change of Volume
(56)	11056 = 120 × (0.83) × 111	12.83	=	13.66	− 0.83
(57)	− 25308 = 120 × (1.9) × 111	12.83	=	14.73	− 1.9
(58)	− 36364 = 120 × (2.73) × 111	12.83	=	15.56	2.73
(59)	− 31000 = 120 × (2.33) × 111	12.83	=	15.16	− 2.33
(60)	14252 = 120 × 1.07 × 111	12.83	=	11.76	+ 1.07
(61)	aq. 31800				

TABLE IV.

Experimental Data Illustrating Table III.

	Heat of Formation.		Theor.	Obs.	
(63)	aq. $Cd.C.O_3$ − 31000 − 18886 + 82841 + 2(96155)	=	179765	181890	
(64)	$Cd.C.O_3$ − 25808 − 18886 + 82841 + 2(96155)	=	185457	183200	
(65)	aq. $Cd.Cl_2$ − 31800 + 2(63870)	=	96440	96400	96250
(66)	$Cd.Cl_2$ 14252 + 23010 + 56786 (corresponds with No. 29.)	=	94048	93700	
(67)	aq. $Cd.F_2$ − 31800 + 2(77500)	=	123700	123500	
(68)	$Cd.S.O_4$ − 36364 + 0 + 2(82841) + 2(96155)	=	220628	219900	
(69)	aq. $Cd.S.O_4$ − 31800 + 6217 + 2(82841) + 2(96155)	=	231909	231600	
(70)	Cd.S 14252 + 19278	=	33530	34000	34400
(71)	Cd.O − 31000 + 96155 (corresponds with No. 51.)	=	65155	66300	63900

(72)	$Cd.N_2.O_6.4H'_2O$ 11056 2(23300) + 6(32341) 4(3205)		123570	121160	
(73)	$aq.Cd.N_2.O_6$ 31300 2(23300) + 6(32341)		116146	116120	
(74)	$Cd.O_2.N_2O_4.4H'_2O$ 11056 + 2(32341) + 85332 - 4(3205)	-	126138	128810	
(75)	$aq.Cd.O_2.N_2O_4$ - 31800 + 2(32841) + 85882	=	118714	118770	
(76)	$Cd.N_2.O_6.H'_2O$ - 31000 2(28800) + 6(32841) - 3205	=	113241	113800	
(77)	$aq.Cd.O.N_2O_5$ 31800 + 32841 + 85882	=	86878	86000	
(78)	$Cd.Br_2.4H'_2O$ 11056 + 2(52930) 4(3205)	=	81984	82980	
(79)	aq. $Cd.Br_2$ - 31300 + 2(52930)	=	74560	75640	
(80)	$Cd.Br_2$ 31000 + 2(52930)	-	74860	75200	
(81)	$Cd.I_2$ 25308 + 2(36226)	=	47144	48880	
	(corresponds with No. 30.)				
(82)	$aq.Cd.I_2$ 31300 + 2(37720)	=	44140	47870	
(83)	Cd.Se pp. - 25308 + 46380	=	21072	23700	
	(corresponds with No. 39.)				
(84)	Cd.Se cryst. 31000 + 46880	=	15880	14800	
	(corresponds with No. 52.)				
(85)	aq. H. Cl - 24350 + 68870	=	89520	39815	Thomsen
(86)	aq. $Ba.Cl_2$ 72134 + 2(63870)	=	199874	199210	
(87)	$Ba.S.O_4$ 81926 + 0 + 2(82341) + 2(96155)	=	338918	339400	
(88)	liq. $H_2.O$ - 2(24350) + 117460	—	68760	68360	Thomsen
				69000	Berthelot
(88A)	aq.K.O.H 36100 + 96155 - 15800		116955	116460	T
(89)	aq. $K_2.S.O_4$ 2(87274) + 6217 + 2(32341) + 2(96155)		337757	338000	
(90)	$aq.H_2.S.O_4.H'_2O$ 2(24850) + 6217 + 2(32341 + 96155) 3205		211304	210770	T
(91)	$aq.H.N.O_3$ - 24850 28800 + 3(32341)	=	49878	49090	

Heat of Solution of Metal.

When Cd and twice (85) produce (65) and H_2,

0 becomes - 31300

- 2(24850) becomes 0

(93) - 31800 + 2(24850) = 17400 17610 Thomsen

Heat of Solution.

When (66) produces (65),

14252 becomes 31800

23010 becomes 63870

56786 becomes 63870

(94) 2(63870) - 23010 56786 - 31300 14252 = 2892 3010 T

Heat of Decomposition.

When (69) and (86) produce (87) and (65),

72134 becomes 81926

6217 becomes 0

(95) 81926 - 72134 - 6217 3575 5688 T

HEAT OF SOLUTION.

When (68) produces (69),

36364 becomes - 31300
0 becomes 6217

(96) - 31300 + 36364 + 6217 = 11281 10740 T

HEAT OF NEUTRALISATION.

When (69) and (88A) produce (89) and (71) and (88),

31300 becomes - 31000
2(36100) becomes 2(37274)
96155 becomes 117460
- 2(15300) becomes - 2(24350)

(97) 31000 + 31300 + 2(37274) -
2(36100) + 117460 96155 +
2(15300) 2(24350) - 5853 7066 T

HEAT OF NEUTRALISATION.

When (71) and twice (85) produce (65) and (88),

96155 becomes 117460
- 31000 becomes 31300

(98) 117460 96155 31300 + 31000 = 21005 20290 T

When (71 and (90) produce (69) and (88),

2(96155) becomes 2(117460)
- 31000 becomes 31300
- 2(15300) becomes 2(24350)

(99) 2(117460) 2(96155) - 31300 +
31000 2(24350) + 2(15300) = 24210 24220 T

When (71) and (91) produce (73) and (88), the changes are the same as in No. 98 and total 21005 20620 Thomsen

TABLE V.

	Magnetic Rotation.		Theor.	Obs.	Corresponds with No.
(100)	$CdCl_2$ 3.77 + 2(3.932)	=	11.634	11.78	85
(101)	$CdBr_2$ 3.77 + 2(7.95)	=	19.67	19.7	
(102)	$CdBr_2$ 3.66 + 2(7.95)	=	19.56	19.7	80
(103)	CdI_2 3.77 + 2(18.32)	=	40.41	40.3	36, 31
(104)	$CdSO_4$ 3.66 + 1.518	=	5.178	5.17	54

Half the atomic weight divided by 14.78 = 3.77.
Half the atomic weight divided by 15.16 = 3.66

The theoretical value for Cl is supported in six other cases, the only ones available, as shown in the demonstration of the Law of Magnetic Rotation in *The Chemical News*, 1923, CXXVI., 199. Similar remarks hold for the values given for Br, I and SO_4.

SUMMARY.

Each one of these (104) facts takes its part in the proof that Cd = Na_2 Zn. At the same time the three new laws of heat of formation, relative volume, and magnetic rotation are considerably strengthened, and there is a continuation of the conversion of the facts of specific gravity into exact instruments of research. It also continues the demonstration that heat is absorbed when liquid water becomes water of crystallisation, and vice versa; especially in Nos. 72, 74, 76, 78, 97 and 99.

The following remarks apply to all the preceding twenty one proofs in other papers, *mutatis mutandis*, as well as to this one. There are in general as many proofs in each paper as there are volumes in Table I., which have a structural interpretation assigned to them.

The first proof :—In Nos. 8-21 there are eight independent demonstrations that

12.83 is an exact relative volume of metallic Cd at 15° C. In No. 2, Table I., it is shown that this volume splits up into parts (which have previously been shown to be volumes of Na and Zn) in accordance with the law of rel. vol. given below. In Table III. this volume is shown to be the exact original volume required in all five cases in accordance with the law of H.F. given below. In Table IV. *et seq.*, each of the five values of H.F. which give this original volume is demonstrated in several ways.

Another proof: -14.73 has been shown in ten independent cases, Nos. 30-40, to be a relative volume of Cd. In No. 5 it is shown to be in accordance with the law of rel. vol. In Table III. it is shown to correspond with the H.F. - 25308, and in Table IV. three examples of this are given. In Table V. this volume gives the correct Magnetic Rotation in accordance with the law given below.

There are four other proofs taking the other volumes in Table I. as starting points respectively. These six proofs constitute one unassailable proof that the correct structure of Cd has been obtained; and the proof is constructed upon 100 experimental facts provided by men who are or were experts in their several domains.

The Law of Relative Volume:

The relative volume of an atom is the sum of the relative volumes of its parts, any one or more of which may be zero.

The Law of Heat of Formation:

The heat of formation of an element is proportional to the product of the atomic weight and the change of volume; there being two distinct series, the sodium elements and the sub-sodium elements.

The Law of Magnetic Rotation: –

The magnetic rotation of an electro-positive element, when in combination ,is the product of half its atomic weight and the reciproca lof its relative volume.

THE REACTION BETWEEN BISMUTH TRISULPHIDE AND HYDROCHLORIC ACID.

By S. Ramachandran.

In a previous paper (this Journal, Vol. CXXXI., 3411, p. 185), I have pointed out that bismuth trisulphide could not be precipitated from a solution of bismuth trichloride in concentrated hydrochloric acid and that freshly precipitated bismuth trisulphide is soluble in cold concentrated hydrochloric acid (about 30° C.). The following is an account of further work of a purely qualitative nature on the same subject.

Experimental.

(1) Small quantities of bismuth sulphide were placed in several test tubes and 5 c.c. of hydrochloric acid of different concentrations added. The results obtained are tabulated below: –

	Concentration of Acid.	Observation.
1	Cold Con. 1.16 S.G.	The substance readily dissolved with evolution of hydrogen sulphide.
2	1 : 1 Aq.	The substance dissolved almost completely in the cold with evolution of hydrogen sulphide. On slight warming a colourless solution was obtained.
3	2 : 5 Aq.	There was a clear evolution of hydrogen sulphide with a partial dissolution of the bismuth sulphide in the cold. On warming, copious evolution of hydrogen sulphide was observed, and a clear solution resulted.
4	1 : 3 Aq.	A result similar to the above was obtained.
5	1 : 4 Aq.	The compound dissolved on boiling continuously for a couple of minutes with evolution of hydrogen sulphide.
6	1 : 5 Aq.	A result similar to the above was observed.
7	1 : 10 Aq.	On vigorous boiling hydrogen sulphide was obtained continuously. The resulting turbid liquid was filtered off and hydrogen sulphide passed through the clear filtrate when cold. A brownish-black precipitate easily souble in cold con. hydrochloric acid was obtained, showing thereby that some bismuth sulphide had undergone reaction with boiling acid of this strength.
8	1 : 16 Aq.	A result similar to the above was obtained.

(2) About 5 c.c. of hydrochloric acid of the various concentrations noted below was added to small quantities of bismuth sulphide in tiny lumps placed in several test

tubes and the approximate temperature at which the evolution of hydrogen sulphide begins in each case was noted. The results obtained are tabulated below:

Concentration	Temperature at which evolution of hydrogen sulphide begins.
1 1 : 1 Aq.	Hydrogen sulphide evolved at about 30° C.
2 1 : 2 Aq.	,, ,, ,, 30° C.
3 1 : 3 Aq.	,, ,, ,, 38° C.
4 1 : 4 Aq.	,, ,, ,, 50° C.
5 1 : 5 Aq.	,, ,, ,, 65° C.
6 1 : 7 Aq.	,, ,, ,, 75° C.
7 1 : 10 Aq.	,, ,, ,, 80° C.
8 1 : 16 Aq.	,, ,, ,, 85° C.

N.B. -Acid hydrochloric "Merck" pure S.G. 1.16 was used throughout.) Pure bismuth trisulphide was obtained as mentioned in Treadwell's *Quantitative Analysis*, Vol. II., Page 180; 1915 edition.

Summary.

1 It has been observed that hydrochloric acid of all concentrations up to 1 : 16 Aq. act upon bismuth trisulphide with liberation of appreciable quantities of sulphuretted hydrogen.

2 Bismuth trisulphide is easily soluble in boiling hydrochloric acid of approximate concentration 1 : 5 Aq.

3 In the reaction between hydrochloric acid and bismuth trisulphide, the more dilute the acid employed the higher is the temperature at which the evolution of sulphuretted hydrogen begins.

Further work on this subject is in progress.

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6 October, 1925.

TEN YEARS OF CHEMICAL PROGRESS EPITOMIZED AT CHEMICAL EXPOSITION, NEW YORK.

Ten years of American chemical progress were epitomized at the Tenth Exposition of Chemical Industries which closed at the Grand Central Palace, New York, on October 3rd, after one of the most successful expositions ever held in the United States. Over sixty thousand representatives of technical and business interests attended the Exposition during the week at the Grand Central Palace. Exact attendance records show that 67,836 persons visited the Exposition, and that of this number, 12,164 registered as representing some branch of a chemical, chemical process, or chemical consuming industry.

The Chemical Exposition was the nucleus of a gala "chemical week" in New York. About fifteen societies and associations of the chemical, chemical eng'neering, and allied fields held individual meetings in conjunction with the Exposition, or participated in group meetings. Headed by a four-day session of all sections of the American Chemical Society east of the Mississippi River, the society gatherings attracted the largest body of chemical executives and chemists ever assembled in a single city at the same time. A chemical industries banquet, at which United States Senator James W. Wadsworth, junr., was chief speaker, was attended by over six hundred persons. Visitors from almost every country of the globe were registered during the week of the Exposition, China, India, South America, Canada, and all the countries of Europe being represented.

The Chemical Exposition, about which all the activities of the week revolved, had something slightly less than four hundred exhibits from industrial organisations. Everything from the finest in precision instruments up to large scale filter-presses, evaporators, and chemical kettles, were displayed. New developments in plant and laboratory equipment, new chemical products, new dyestuffs, new processes of chemistry in the chemical and other industries, many of them actually revolutionary in character, only emphasised the tremendous progress of American chemistry during the past few years. More new products were displayed at the Chemical Exposition this year than at any previous Chemical Exposition, going back to the original exhibits in 1915.

One of the innovations at this year's Exposition was the origination of a Court of Chemical Achievement, in which were entered, in the form of small exhibits, many of the new developments in chemical products and chemical processes in the United States which have come to the front during the past few years. Altogether 307 new products were shown in this Court by 22 organisations alone. At the various exhibits, representatives of the company or group owning or controlling the product or process were on hand to explain its history

and uses to visitors; a brochure of eighty-eight pages was published, briefly describing the achievements on view.

Another feature of the 1925 Chemical Exposition which was unusually successful, was a one-week intensive course in the fundamentals of industrial chemistry and chemical engineering for students of chemistry or chemical engineering from various colleges and universities throughout the country. Lectures and practical demonstrations were held each morning at the Grand Central Palace. Leading authorities in the various fields of American chemistry acted as lecturers. At the course, over twenty American colleges were represented by two hundred students.

Of the outstanding developments which received more than ordinary attention at the Chemical Exposition this year, was a splendid exhibit of chemical fibres of the artificial silk type, and which occupied the section labelled "Chemistry's contribution to the "Textile Industry." The entire manufacture of the fibres or filaments from raw material to finished garment was completely covered by the exhibit. Even the machinery with which the various steps were accomplished, was shown.

The chemical work of the United States Government was well displayed. Chemistry as part of modern warfare received a great deal of attention during the week. The United States Army Chemical Warfare Service was represented with new products in the Court of Chemical Achievement, and the Government was also an exhibitor in a large series of exhibits by a number of bureaus of the Department of Agriculture and the Department of Commerce.

The management of the Chemical Exposition this year was in the hands of the same men who originated the 1915 Exposition at the same place, the Grand Central Palace, New York, the first of its kind ever to be held. Charles F. Roth and Fred W. Payne were the co managers. Associated with them was an advisory committee made up of prominent chemists and executives of the chemica lindustry, headed by Dr. Arthur D. Little, of Boston, who won world-wide fame several years ago by producing, chemically, a silk purse from a sow's ear.

So well pleased were the exhibitors with the Exposition and its results that at a meeting of a large body of them, an enthusiastic and unanimous vote "that the Exposition management be commended and thanked for the conduct of the best Exposition that had been held in the past ten years," and the announcement of the next Exposition with an interval of two years was hailed with enthusiasm.

The next Exposition of Chemical Industries, the eleventh, will be held at the Grand Central Palace, New York, two years hence, during the week of September 26 to October 1, 1927. Although the Eleventh Chemical Exposition is two years off, the majority of leading exhibitors have already contracted for their spaces for 1927.

Trade and General Notes.

DRIVING SODIUM ATOMS THROUGH GLASS.

The use of photoelectric cells for the conversion of light energy or of light-ray signals into electric energy or electric signals is growing in many fields of scientific and industrial work, including radio. Most of these photoelectric cells depend either on the element selenium or on one of the alkali metals, sodium, potassium, rubidium, caesium and lithium. Much interest attaches, therefore, to a process, recently perfected by Dr. Robert C. Burt, of the California Institute of Technology, by which sodium atoms can be driven through the glass walls of an ordinary electric lamp bulb, producing a coating of very pure metallic sodium on the inside walls of the bulb. The bulb is placed, tip down, in a bath of melted sodium nitrate, kept at a temperature of approximately 312 degrees, Centigrade (588 degrees, Fahrenheit). A current is passed through the filament of the bulb in the usual manner. An electrode dips into the melted sodium nitrate, and a voltage of approximately 220 volts is maintained between this electrode and the midpoint of the filament in the bulb, the filament being negative. Under these conditions, when electrons escape from the heated filament (just as they do from the filament of a radio vacuum tube) they are drawn against the inside surface of the glass by the potential difference between the filament and the outside bath of fused sodium nitrate. It is as though the glass were the plate of a vacuum tube.

The glass of the bulb contains sodium and the atoms of this sodium (or some of

them) are able to move around in the glass. When the electrons from the filament hit against these mobile sodium atoms they neutralise them and the atoms then come out on the surface of the glass and form a layer of metallic sodium. What happens, in the language of the physical chemist, is that sodium *ions* in the glass acquire one electron each, and become free sodium *atoms*. Meanwhile, new sodium ions enter the outside surface of the glass, coming from the bath of sodium nitrate. The over-all effect is, therefore, the driving of sodium atoms through the glass, to produce a metallic layer on the inside.

While this process is not at all difficult to carry out in any well-equipped laboratory there are some conditions and precautions which cannot be described in a brief note. Experimenters intending to make use of Dr. Burt's process should first consult his paper referred to, where they will find all necessary details.

From "Popular Radio."

LIME PRODUCTION IN CANADA DURING 1924.

The production of lime in Canada during 1924, according the the Dominion Bureau of Statistics, totalled 9,137,009 bushels, consisting of 7,820,209 bushels of quicklime and 1,816,800 bushels of hydrated lime, with a total valuation of $8,178,541. In 1923, the production was 10,085,819 bushels, valued at $8,266,608.

FELDSPAR PRODUCTION IN CANADA IN 1924.

The production of feldspar in Canada during 1924, according to the Dominion Bureau of Statistics, as shown by the sales of Canadian feldspar in 1924, advanced to a new high level of 44,804 tons, valued at $358,540. In 1923, shipments totalled 29,225 tons, valued at $237,601. In 1924, shipments comprised 16,147 tons from Quebec deposits, and 28,657 tons from 11,000 tons to a total of 37,869 tons, while the imports also showed an increase of 200 tons to a total of 1,821 tons.

SUGAR BEET IN SOUTH AFRICA.

Mortimer.—Does sugar beet do well in this country, and what will it be like under Irrigation Also, have factories been established for the manufacture of sugar?

Grootfontein School of Agriculture replies: Sugar beet is utilised mainly for the manufacture of sugar, although in this country no attempt has been made to utilise the crop for this purpose. As a factory costs several hundred thousand pounds and only works for about three months a year, it must be clear that before one can be established, a considerable area of sugar beet must be grown in order to guarantee a sufficiently large quantity of beet. It is estimated that 2,000 acres of sugar beet must be grown annually before a factory can be established, and as the crop cannot be grown on the same lands every year ,some 6,000 or 8,000 acres are required in order that a proper rotation with sugar beet every three or four years can be carried on. This land must be in close proximity to the factory. That sugar beet can be grown satisfactorily under irrigation is well known and recent experiments in the Gamtoos Valley seem to show that this crop grows fairly wel lunder irrigation in the coastal area, and that the sugar-content is sufficiently high for factory purposes. This crop requires a tremendous amount of hand labour in connection with harrowing, thinning, harvesting, and topping. -*Journal of the Department of Agriculture, Union of South Africa.*

FEDERATION OF BRITISH INDUSTRIES.

In the course of a long letter to the Prime Minister, the Director says: -

"The Federation of British Industries have urged on His Majesty's present Ministers and their predecessors on many occasions the pressing necessity of a substantial reduction of Government expenditure and its accompanying burden of taxation. They feel compelled to do so again by the very grave position which confronts industry at the present moment.

They are well aware that heavy taxation is not the only, nor even perhaps the chief, of the many difficulties which face British industry, but its reduction is beyond question among the greatest contributions which can be made by the Government towards their solution.

In this connection it should be pointed out that while Government expenditure has apparently fallen by some 30 per cent. since 1920, £1,195,428,000 for 1920-1921 against £799,400,000 estimated, for 1925-1926), this reduction is largely, if not entirely,

illusory, since the purchasing power of the £ sterling as measured either by retail or wholesale prices has increased by approximately 30 to 31 per cent. during the same period. Actually, therefore, the Government expenditure for 1925-1926 is approximately the same in real values as that for 1920-1921. All that has happened is that this expenditure is now measured in fewer pounds sterling at a higher value."

CHAIR OF INDUSTRIAL CHEMISTRY AT McGILL.

In the will of the late Mrs. E. V. Eddy, widow of the founder of the E. B. Eddy Company, paper and wooden goods manufacturers, the sum of $200,000 was provided to establish a Chair of Industrial Chemistry at McGill University, Montreal. To this newly-established Chair, Professor Harold Hibbert, D.Sc., Ph.D., late of Yale University, and one of the best known Industrial Chemists, has been appointed. Dr. Hibbert is a graduate of Victoria University, Manchester, going from there to Leipzig, Germany, where he took his Ph.D., and returned to Manchester and secured his D.Sc. Dr. Hibbert is at present in Europe, engaged in an investigation of developments in the pulp and paper and cellulose-using industries. This study will be of great value to the new course at McGill, owing to the advance being made in the pulp and paper and artificial silk industries in Canada.

COPPER PRODUCTION BY PROVINCES IN CANADA IN 1926.

	Quantity Pounds	Computed Value $
Quebec ..	1,898,008	246,516
Ontario .	37,113,193	4,833,622
Brit. Columbia	65,451,246	8,524,370
Canada .	104,457,447	13,601,538

CANADIAN TOBACCO CROP IN 1924.

The Canadian tobacco crop for 1924 is estimated at 18,710,740 pounds with a farm value of $4,358,898. The area under crop was 21,817 acres, situated in the provinces of Ontario and Quebec.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Dielectric Problems in High-Voltage Cables, by P. Dunsheath, O.B.E., M.A., B.Sc., Member.

The paper deals with several important problems of particular theoretical and practical interest at the present time in connection with the design, manufacture, and operation of high-voltage impregnated-paper cables.

In the first place, the phenomenon of dielectric absorption is discussed as a question of fundamental importance ,and as a basis for a proper understanding of dielectric losses. It is shown how dielectric resistance must be carefully defined in order to be of any value as a characteristic of cable quality, or in analytical discussion, and the results of experiments are given to show that whilst the usually accepted absorption expression departs from the truth, it can be used within limits. Experimental work on absorption in different dielectrics and on the effect of moisture and temperature on the constants is also described.

The dependence of alternating dielectric losses on direct-current characteristics is discussed, and the author suggests a conception of the former in which they can be explained at I^2R losses, without retaining the difficulties of a dielectric hysteresis.

Several new points are brought to light and supported by experimental evidence in a discussion of the relationship between d.c. and a.c. losses. The nature of the "V" curve connecting dielectric power-factor and temperature is investigated, and an explanation of the "V" curve is suggested based on the I^2R theory of losses.

The paper also discusses the rise of power factor with voltage, the important effect of time on the breakdown strength, and the bearing which this has on the effect of surges in a system. In conclusion, some suggestions are made on the nature of breakdown and the assessment of cable quality.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society held at the Imperial College on Thursday, 15 October, 1925, the following papers were read and discussed.

On Brewster's Bands, by PROFESSOR C. V. RAMAN, F.R.S., AND SUSHIL KRISHNA DATTA, M.Sc.

The paper considers the explanation of Brewster's bands and other allied phenomena from the new and very suggestive standpoint proposed by Schuster (*Phil. Mag.*, Oct., 1924). When monochromatic light is reflected by or transmitted through two parallel plates in succession, we have a superposition of the Haidinger ring-systems due to the two plates in the sense that the observed intensity in any given direction is the product of the intensities due to either plate separately. Illustrations showing the effect of such superposition in various cases are reproduced in the paper, differential and summational fringe-systems of various orders being observable. When non-homogeneous light is used, the Haidinger rings disappear and with them also the superposition pattern, leaving only a uniform thickness. A simple geometrical explanation is thus forthcoming why Brewster's bands can be observed even in non-homogeneous light with thick plates in this case.

Lagrange's Theorem and Stationary Functions, by T. SMITH, M.A., F.Inst.P.

Lagrange's theorem for several variables is expressed in a concise notation and used to evaluate a function which is stationary for small changes in each of its variables.

Some New Instruments for Recording Rapidly Varying Phenomena, by W. G. COLLINS, of the Cambridge Instrument Company, Ltd.

In these instruments, a fine stylus terminating in a highly polished spherical surface of small radius rests on a travelling strip of transparent celluloid. A record of the movement of the part of the instrument to which the stylus is fixed is obtained by the permanent deformation of the surface of the celluloid by the stylus. As this deformation is produced by very slight pressure, and no material is removed from the celluloid, the energy required to produce the record is very small. The depth of the trace is of the order of 2 to 8 microns and of proportional width. Thus, only a comparatively small amount of celluloid film is required, and the record is immediately available for examination by optical methods. The device has been employed in several instruments which have been designed and constructed for such purposes as measuring the vibrations in a travelling motor car or railway coach, determining the amplitude and characteristics of the vibration set up in roads by the passage of various types of vehicles, recording rapid changes of stresses in materials or structures subject to varying loads, such as railway bridges, and for recording high frequency variations in gas pressures, as in the cylinders of high speed internal combustion engines.

THE PHYSICAL SOCIETY OF LONDON AND THE OPTICAL SOCIETY.

Sixteenth annual exhibition of electrical, optical and other physical apparatus, Tuesday, Wednesday, and Thursday, January 5, 6 and 7, 1926.

The Councils of the above Societies have decided to extend the scope of the annual exhibition by including, in addition to the usual display by instrument makers, the following new classes of exhibits:—

(*a*) Exhibits illustrating the results of recent physical research and improvements in laboratory practice.

(*b*) Selected examples of effective lecture experiments.

(*c*) Repetitions of famous historical experiments in physics.

Accommodation for these will be provided in a part of the Imperial College distinct from that devoted to the trade exhibits, and a section of the catalogue will be alloted to them.

No charge will be made for space or catalogue entries in the new classes, and the facilities of the Imperial College will be at the disposal of exhibitors.

The object in view in inviting exhibits of classes (*a*) and (*b*) is to afford to teachers and research workers an opportunity for interchanging ideas and disseminating information on matters relating to their work in practical physics. The exhibits in class (*c*) will be of interest not only to the scientific worker, but to the general public, who will have an opportunity on the third day of attending the exhibition. An effort will be made by this means to impress upon the public the connection between the lesser known fundamental physical

phenomena and their more widely known practical developments. Promises of support have already been received from a number of Research Laboratories and Institutions in class (*a*).

The Councils of the Societies appeal to all Fellows for their support both by personal offers of exhibits or demonstrations, particularly in classes (*b*)and (*c*), and by making the scheme widely known.

Offers giving preliminary particulars should be addressed to the Secretary of the Physical Society at the Imperial College of Science, South Kensington, as early as possible, and not later than November 16.

CHEMICAL, METALLURGICAL AND MINING SOCIETY OF SOUTH AFRICA.

Problems of the Immediate Future.

From the Presidential Address by H. A. White.

(*Delivered at the Ordinary General Meeting at Johannesburg*, 15 *August*, 1925.)

" The motto of this Society has been freely translated as ' Let us equal our opportunities,' and in order to carry this into effect it is useless to sit in our armchairs and contemplate the distant future. We must arise and consider what is immediately before us, and what we have to do to carry on the torch handed on by our predecessors.

In the first place, though as men of science we have as yet no direct voice in the government of this country, we may at least utter our views on such questions as the development of local industries which is now promised official encouragement and financial support.

As actual instances it is considered that the present manufacture of carbide might be expanded to include its transformation to cyanamide and the further conversion to cyanide to supply not only this industry but also the demands for fumigation and agricultural purposes. In this case all the materials are found in abundance in the country, and cheap power should ensure a rapid success. In addition to the shoes and dies, now well established as a local manufacture, other battery parts such as cams and tappets are being made successfully, and we hope to see in the near future most of the gold mining machinery made in this country. In any case, cam shafts, tube mills, mortar boxes, rock drills, drill steel, wire ropes, truck wheels and a host of smaller requisites should soon be made locally, and a steel industry of modest dimensions should be established in the near future. We have the coal and iron ores, and our railways, mines and manufactories should form a sufficient local market for a promising start.

For some time to come, however, our coal mining and gold mining will form the principal industries, and it certainly would be a welcome change if they received Government support. At least, however, we may hope that new leases will soon be given out and new mines started to replace those whose life is now limited. Forethought in such matters is stimulated by the reflection that five years is a short time to bring a new mine to the producing stage. Fortunately, there is a great hope that platinum in the near future may be developed into a great industry, and it is hoped that we may have many papers dealing with the extraction of this metal, and that our members may be helpful in solving the problems which are sure to arise in this connection.

Turning now to the immediate future of the gold mines, the most important requisite is the maintenance and improvement of good relations between owners and employees and the demarcation of spheres of employment between white and native labour is closely connected therewith. It is clear that no hurried or rigid solution can be stable. It is possible that some education of public opinion must precede the only permanent solution. This must essentially include even-handed justice to all concerned, involving the giving to every man opportunity equal to his capacitw and payment according to actual production. The slow but sure natural process of " trial and error ' will solve the minor problems involved, and this is the method now actually in use which determines the share of the mutual production which is enjoyed by natives, white employees, staff, directors, and even the oft-forgotten shareholder himself.

But while a large share of our energies must be devoted to improvement in efficiency of production of gold, we can, no more than any other large industry, evade the necessity of advertising our product. It is only a convenient economic fiction that gold is stable in price and the market unlimited. Extended use in currency, so necessary for financial stability, as recent

history proves beyond peradventure, should be advocated at all times and in all possible places. The natural result of a rise in values thus caused will profit our industry very greatly; the advantage, of course, being realised in decreased cost of production which is absolutely necessary for the expansion of the industry, and the beneficiation of the hugh reserves of low-grade ore accumulated in our mines."

NOTICES OF BOOKS.

SOME RECENT GERMAN BOOKS ON CHEMICAL SCIENCE.

There is abundant evidence that scientific work is being pursued in Germany as vigorously as ever. A glance at the abstract journals will indicate that the volume of work published by German chemists continues to increase and the large publishing houses are still issuing many new treatises every week. Much of the literature published, it is true, is of very secondary importance, but at the same time, many valuable contributions to science are also forthcoming.

Among the new books are three important ones on Colloid Chemistry. This is very natural, since the subject has recently assumed such technological importance. Clay, silica gels and emulsions are three of many examples of matter in the colloidal state which is being dealt with industrially in enormous quantities.

Prof. Zsigmondy's *Kolloidchemie* (pp. XII. + 246, published at 18 marks, 50 pf., by Otto Spamer, Leipzig), has reached its fifth edition, which appears to have been long overdue. This work deals especially with the theoretical basis of the subject, and is, perhaps, the standard treatise on colloid chemistry.

A second work in this field is by Prof. Andor Fodor, who is Director of the Institute for Biochemistry and Colloid Chemistry at the Jewish University of Jerusalem. Its title is *Die Grundlagen der Dispersoidchemie*, and it is published by Theodor Steinkopff, Dresden and Leipzig, pp. VIII. + 280, price 12 marks. It deals with the theoretical views on disperse systems and their applications in biology.

The third volume, entitled *Die Allegemeinheit des Kolloidzustandes*, also published by Theodor Steinkopff, price 27 marks, pp. XVI. + 506, is by Prof. P. P. von Weimarn, who, unlike most Russian émigrés, has gone east instead of west, and having found refuge at Tokyo and Sendai, has not neglected to work energetically. His book, perhaps the most readable of the three, since it is a translation, and therefore written in simple language, first appeared in 1921 in Japan, when 300 copies were printed and immediately disposed of among the professor's students and others attracted to his lectures. The second, and enlarged, edition, was made possible by the aid of the Japanese Chemical Society, which advanced 8,000 yen towards the cost of publication, which certainly must have been heavy, considering the number of illustrations and tables.

Von Weimarn is an ardent exponent of the view that all matter can exist in either the crystalline or colloidal state, and that substances in either of these states can, by suitable means, be converted into the other condition. The properties and phenomena associated with colloids appear spontaneously for each solid body on progressive dispersion to the necessary extent, no matter how that dispersed state is reached. Although the author has published much in support of these views in various scientific periodicals, the book contains a good deal of original matter which appears for the first time.

Another interesting point about the book is that, toward the end, a portrait (one of the only two in the book) of Graham is given. The author has not neglected to give a discriminating historical survey of the development of colloid science.

Theodor Steinkopff has also recently published Part 11. of Dr. Alfred Benrath's *Physikalische Chemie*—No. 14 in the series on Scientific Research, edited by Professor Liesegang, pp. X + 192, price 9 marks, 70 pf. This part deals with thermo-chemical and photo-chemical equilibria and reaction velocities, and correlates much that has only recently appeared in the scientific journals. Its chief use will be for the help of research students.

Another physico-chemical work emanating from the same publisher is Dr. Fritz Lowe's *Optische Messungen des Chemikers und Mediziners*, pp. XII., + 166, price 7 marks, 20 pf. This work is written as a guide to chemists and medical research workers on the use of optical instruments. The author is connected with the firm of Zeiss of Jena. Such a work in German fills a long-felt want, as it presents to busy re-

search workers the applications and possible uses of such instruments as the various spectroscopes, refractometers, and interferometers.

A new *Lehrbuch der Organischen Chemie*, by Prof. J. von Braun, pp. XII. + 508, price 24 marks, has just been published by S. Hirzel, of Leipzig. The treatise follows the conventional lines except that the final section of some 30 pages deals with the historical development of organic chemistry in which, it may be pointed out, scanty reference is made to the contributions of British scientists.

Gebruder Borntraeger are still publishing parts of the General Handbook on Coal, compiled by the Kaiser Wilhelm Institute for Coal Research at Mulheim. This volume, the seventh, price 16 marks, 50 pf., covers the years 1922-23, and is of considerable importance to those concerned in the coal industry.

It is interesting to note that among the works on applied chemistry, a new edition of Dr. Moldenhauer's *Chemisch-technisches Praktikum* has been published, pp. VIII. + 264, price 14 marks 25 pf., Gebruder Borntraeger, Berlin. Some chapters have been curtailed, others expanded. The book is primarily intended for students of applied and analytical chemistry. It will be recalled that an English translation of the previous edition appeared in 1921. The translator was Dr. Lawrence Bradshaw, and the publishers are Messrs. Constable. (A review of the translation appeared in the *Chemical News*, 1922, CXXIV., 158.)

Dr. Moldenhauer first gives a chapter on general procedure, which is followed by sections devoted to each branch of chemical technology. The book thus covers practically the whole field of applied chemistry.

J. G. F. D.

FORTHCOMING EVENTS.

ROYAL SOCIETY

At the meeting on November 12, at 4.30 p.m., papers will be read by Sir William Bragg, F.R.S., and R. G. Gibbs; Sir Walter Rayleigh, F.R.S.; W. A. Bone, F.R.S., and G. W. Andrew; C. W. Richardson, F.R.S., and F. C. Chalklin; R. Campbell Thompson; J. E. Lennard-Jones, and others.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London, W.C.1.

172ND SESSION, 1925 1926.

Wednesday, November 11, 8.30 p.m. (Trusman Wood Lecture) Sir Cecil Harcourt-Smith ,C.V.O., LL.D., late Director and Secretary of the Victoria and Albert Museum, "The Modern Note in Industrial Art." Rt. Hon. The Earl of Crawford and Balcarres will preside.

Wednesday, November 18, 8 p.m. (Ordinary Meeting) I. C. Goodison, of H.M. Office of Works, "The Furniture of Hampton Court." H. Avray Tipping will preside.

Friday, November 20, 4.30 p.m. (Indian Section) Professor Edward Percy Stebbing, M.A., F.L.S., Professor of Forestry, University of Edinburg, "Recent progress in Indian Forestry."

Monday, November 23, 8 p.m. Cantor Lecture) R. Lessing, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." (Lecture I.)

Wednesday, November 25, 8 p.m. (Ordinary Meeting) David Greenhill, General Manager, The Sun Engraving Co., Ltd., "Colour Printing." Sir Ernest Hodder-Williams, C.V.O., will preside.

Monday, November 30, 8 p.m. (Cantor Lecture) R. Lessing, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." (Lecture II.)

Wednesday, December 2, 8 p.m. (Ordinary Meeting) Lieut. Col. Sir Alan H. Burgoyne, M.P., A.M.Inst.A.E., "The Future of the Motor Car." Col. Sir Thomas A. Polson, K.B.E., C.M.G., M.P., will preside.

Monday, December 7, 8 p.m. (Cantor Lecture) R. Lessing, Ph.D., F.C.S., M.I.Chem.E., "Coal Ash and Clean Coal." (Lecture III.)

Wednesday, December 9, 4.30 p.m. - (Joint Meeting of the Indian and Dominions and Colonies Sections). A paper on "The Imperial College of Tropical Agriculture," by H. Martin Leake, M.A., Sc.D., F.L.S., Director of the College, will, in the absence of the Author, be read by Arthur William Hill, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew. The Rt. Hon. L. S. Amery, M.P., Secretary of State for the Colonies, will preside.

ROYAL INSTITUTION.

A general meeting of the Members was held on Monday, November 2, Sir James Crichton Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Professor Percy Frankland for his gift of a number of relics of Faraday, and to Sir Alfred Yarrow for his donation of £248 14s. towards the cost of advertising the lectures. The chairman reported the death of Dr. H. H. Hildebrandsson, an Honorary Member, and a resolution of condolence with the relatives was adopted. Dr. John Freeman, Mr. W. S. Jarratt, and Viscount Leverhulme were elected Members.

INSTITUTION OF PETROLEUM TECHNOLOGY.

At the meeting on Tuesday next, November 10, at 5.30 p.m., at the House of the Royal Society of Arts, John Street, Adelphi, the following papers will be read:

The Principles of the High Vacuum Distillation of Mineral Oils, by Ing Leo. Steinschneider.

The Determination of Unsaturateds in Petroleum Spirit, by W. R. Ormandy, D.Sc., F.I.C., F.C.S., M.I.A.E., and E. C. Craven, B.Sc., F.C.S.

The Determination of Molecular Weight of Petrol, by W. R. Ormandy, D.Sc., F.I.C., F.C.S., M.I.A.E., and E. C. Craven, B.Sc., F.C.S.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

25,411.- Amann, A. Condensation products of ketones and phenols. October 12th.

25,685. Ayres, E. E. Substitution of hydroxyl groups for the acid radicals in liquid esters, etc. October 14th.

24,687. -Metal Research Corporation. Manufacture of hydrogen. October 14th.

25,785. --Hatfield, H. S.--Chemical analysis. October 14th.

Specifications Published this Week.

230,774.--Neill, O. S.--Heat process of manufacturing ferric oxide.

240,589. - Giles, W. H., and Wilson, H. A. Manufacture of iron oxide pigments and polishing materials.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, W.C.2., at the uniform price of 1s. each.

Abstract Published This Week.

238,038. -Oxidation of hydrocarbons.—Carbide and Carbon Chemicals Corporation, 30, East 42nd Street, New York, U.S.A.

Aldehydes; olefines. -Paraffin hydrocarbons containing more than one carbon atom in the molecule are partially oxidised in the vapour phase at a temperature between 620° and 850° C., each hydrocarbon molecule being subjected to the said oxidation temperature for such a period of time that a result is obtained approximating to that obtainable by subjecting the same molecule to a temperature of 700-710° C. for a period of a little less than one second. An example is given of the oxidation of ethane with air or oxygen at a temperature of 700-710° C., the circulation of the gas mixture being such that a molecule of ethane passes through the furnace in a little less than one second. The condensed product consists of an aqueous solution of formaldehyde together with some acetaldehyde, while the exit gases contain ethylene which can be removed say by absorption in acid. Propane, butane, and higher paraffin hydrocarbons may be similarly treated, when not only are formaldehyde and ethylene produced, but also some of the higher olefines. Gas mixtures containing the paraffin hydrocarbons together with olefines, for example coke oven gas, may be oxidised in the same way. A silicious or vitreous heating surface, for example one of pure silica, is preferred.

THE CHEMICAL NEWS,
VOL. CXXXI. No. 3422.
MERTON HOUSE, SALISBURY SQUARE,
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TELEPHONES:
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Printing Works: Hop 2404.

EKA-CAESIUM AND EKA-IODINE.

By F. H. LORING AND J. G. F. DRUCE.

Referring to our communication in respect of the first-named element above, in this Journal (Nov. 6. 1925), further X-ray experiments have been made on the same crude oxide that apparently gave the characteristic $L\alpha$ line of element 87 together with the characteristic $L\alpha$ and $L\beta$ lines of rhenium (*i.e.*, dvi-manganese), but up to the present we have been unable to get the $87L\beta$ line, possibly for the reason already given. We did, however, succeed in getting what appeared to be the $L\alpha$ line of this element. In addition thereto, on the same film, lines of wave-lengths 1.080 and 0.895 were obtained, though very faint. These lines would seem to correspond with the characteristic $L\alpha$ and $L\beta$ radiations of element 85, that is eka-iodine.

One reason that we seriously considered eka-caesium as being present was that Hartley and Ramage (*Journ. Chem. Soc.*, 1897, p. 533) pointed out that the natural oxides of manganese usually contained traces of potassium, rubidium, silver and copper, whilst gallium, indium and thallium are occasionally present.

Another reason was that the behaviour of another sample made this time from pyrolusite purified with the view of increasing if possible the content of eka-caesium in the final product, exhibited chemical properties rather to be expected from such an element, though present in small quantity. However this may be, the following should be of interest.

The latter sample (from pyrolusite) was then examined by Messrs. Adam Hilger, Ltd., with a view of securing the X-ray spectrum of the new element if present. The film obtained showed a line of wavelength about 1.040, which, allowing for width, would include the $L\alpha_1$ $L\alpha_2$ radiations of eka-caesium. In addition thereto, on the same film, a line appeared of wave-length 0.900. So far as examined, the crude substance containing eka-caesium formed salts, all of which were soluble.

With regard to the eka-iodine lines, which seemed to afford conclusive evidence, owing to the characteristic $L\alpha$ and $L\beta$ lines appearing, we feel compelled, nevertheless, to regard these lines as uncertain indications of this new element being present in the sample; but we will say with confidence that the research we have started on the missing elements in, or in connection with, Group VII., is promising, and the work is being continued.

In conclusion, referring to our previous communication, we should state that Messrs. Hilger did not seem to regard line $\lambda = 1.032$ as anything other than a *first-order* α line of some element present in minute quantity in the sample examined by means of X-rays. We fully realise that much more work is necessary to establish the two elements, here mentioned, on a firm basis.

We should explain that we have relied upon Messrs. Adam Hilger, Ltd., for making the line measurements cited in our communications thus far published. The measurements here given are in Augstrom units, as before.

THEORIES ON THE CONSTITUTION OF NATURAL SILICATES.

By GEOFFREY N. RIDLEY, F.Ph.S. (Eng.).

Silicon, like carbon, possesses the unique power of forming chain and ring systems, and this fact has considerable bearing upon the ultimate constitution of the naturally occurring silicates. Whereas in the carbon compounds constitutions can be readily deduced from a study of derivatives, the corresponding silicon complexes are more difficult to attack. It is only in the organo-silicates that precise molecular weights have been determined, and from these data important knowledge concerning the constitution of silicates in general has been derived. In illustration of this: the molecular formula for ethyl orthosilicate, given as $Si(OC_2H_5)_4$ justifies, to some extent, the

formula $Mg{<}{}^{O}_{O}{>}Si{<}{}^{O}_{O}{>}Mg$ for the

mineral Olivine. Olivine has the empirical composition $2MgO.SiO_2$. In like manner,

ethyl metasilicate, $SiO(OC_2H_5)_2$ represents a certain type of silicate, a member of which is notably Wollastonite, $CaSiO_3$.

Although the silicates themselves are by no means simple, it is certain from various considerations that they are considerably more definite in composition than the corresponding acids. There is no proof that acids of the formulæ H_4SiO_4 and H_2SiO_3 exist as such; the ortho and metasilicic acids are expressed with greater accuracy by the habits $mSiO_2$, $2nH_2O$ and $mSiO_2$, nH_2O where m and n are nearly equal. This brings in the conception of hypothetical polysilicic acids, as they are generally called.

Silicic acid, as a weak acid, forms salts of great complexity and that is one difficulty which has to be surmounted in this investigation of constitutions. This, combined with a propensity for forming chains and rings, as already mentioned, still further obscures the problem. Aluminic and boric acids, in virtue of their feebly acidic properties, also show a similar tendency to produce complex salts. It is interesting to find, as we do, that alumina occurs widely with silica in natural silicate minerals. This is not surprising in itself since aluminium so closely resembles silicon in general chemical properties. All these facts have to be taken into account in the *classification* of the natural silicates. A vast amount of work has been done in this direction, but with doubtful success. Mineral silicates may be tabulated according to the particular form of the silicic radicle. Thus there stands first the orthosilicic class, members of which are olivine, Mg_2SiO_4 and garnet $Ca_3Al_2(SiO_4)_3$ amongst others. Next, there is the metasilicic class containing wollastonite, talc and emerald $Be_3Al_2(SiO_3)_6$. The trisilicic class exemplifies a different form of silicic radicle produced by the condensation of three molecules of o-silicic acid :

$$\left\{\begin{array}{ll} Si(OH)_4 & SiOOH \\ & \quad >O \\ Si(OH)_4 \ldots\ldots & Si(OH)_2 \quad \text{Trisilicic acid.} \\ & \quad >O \\ Si(OH)_4 & SiOOH \end{array}\right.$$

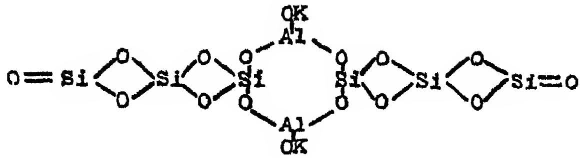
Felspar, $(K,Na)AlSi_3O_8$ is a member. In all these types the minerals have been regarded as silicates. If, however, the probability is accepted that alumina functions as an acidic constituent of the compound, then it is possible to resort to other methods of classification. This unfortunately leads to inconsistency of membership. Cyanite and Andalusite, for example, do not appear to conform to standard types. Both are basic compounds and are formulated respectively :

$$\begin{array}{lll} O-Al & O & \\ & & >Si=O \quad \text{and} \\ O=Al & O & \end{array}$$

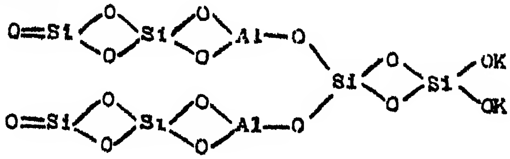
$$\begin{array}{ccccc} & & & O & \\ O=Al & O & Si & O & Al \\ & & & O & \end{array}$$

Tschermak, a well-known worker in this direction, investigated the micas. In his opinion the micas consisted of isomorphous mixtures of three types of molecules : $H_4KAl_3(SiO_4)_3$ (muscovite), $Mg_6(SiO_4)_3$ (olivine) and $H_4Si_5O_{12}$. Clarke believes natural silicates to be derivatives of $Al_4(SiO_4)_3$. The system of Goldschmidt is interesting, in which silicates are derived from polymerised silica molecules ,such as Si_6O_{12} and Si_8O_{16}, by the replacement of silicon atoms by equivalent metallic or other atoms. He is thus enabled to express certain natural silicates in quite a satisfactory manner. Lime Garnet, for example, $Si_3Ca_2(CaAl_2)O_{12}$ is supposed to be a derivative of $Si_3Si(Si)_2O_{12}$ and Arbite : $Si_6(NaAl)_2O_{16}$ from the prototype $Si_6(Si)_2O_{16}$.

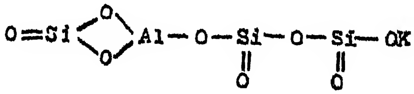
Although these systems are all very ingenious, it is difficult to see where they differ in the essential principle underlying them. Undoubtedly the greatest advance in the study of the constitution of natural silicates has been made by W. and D. Asch. Their exhaustive researches cannot be too highly commended. There are in all three possible solutions of the state of chemical combination existing in natural silicates : they are double salts like alums; isomorphous mixtures of silicates and aluminates or finally salts of complex alumino-silicic acids. It is more than likely that the alumino-silicic theory is the most correct. Vernadsky gives the following formula for orthoclase felspar : K_2O, Al_2O_3, $6SiO_2$:



Tschermak:



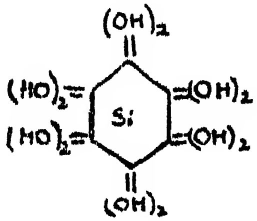
and Groth:

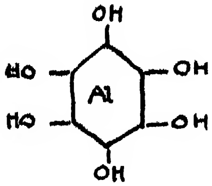


Loew suggests that clay is an anhydrosilicic aluminic acid:

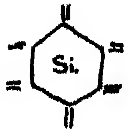
$$O(Si(OH)<{}^{O}_{O}>Al.OH)_2$$

W. and D. Asch have developed the Hexite-Pentite Theory which has the fundamental assumption that all natural silicates contain ten or twelve membered rings of alternate silicon and aluminium and oxygen atoms; they may be looked upon as condensed pentites and hexites. The hydrohexites of silica and alumina are thus shown to be:

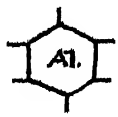




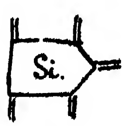
The abbreviated forms are respectively:

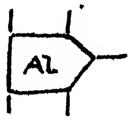


and

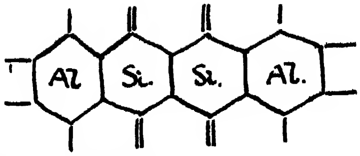


By the condensation of these molecules, through loss of water, the investigators Asch seek to represent all complex silicic or alumino-silicic acids from which spring the naturally occuring silicates. In a similar manner the silica and alumina pentites are abbreviated:

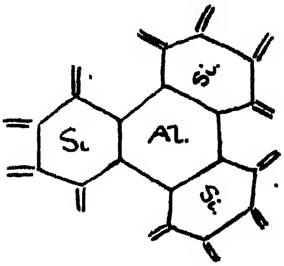




The application of this system may be demonstrated by the case of the silicate $8H_2O.\ 6Al_2O_3.12SiO_2$:



and $12H_2O.3Al_2O_3.18SiO_2$:



These methods of configuration are certainly more trustworthy than the older systems, since they bring in the important factors concerning the chain and ring formation properties of silicon. The use of X-rays for the elucidation of crystal structure will probably throw considerable light on the constitution of natural silicates. Theories concerning bond strain and relative attraction may find employment in these investigations.

Besides the methods of Kipping involving the organo-silicon compounds, others for the study of silicates have been used. Vogt and Doelter prepared artificial minerals by fusing together the constituents present in natural silicates.

At present we are in the habit of classifying the natural silicates in two groups; the anhydrosilicates and the hydrosilicates. This system may be considered to have a universal application. It dispenses with uncertain details concerning the functions of alumina and silica. The anhydrosilicates are less reactive than the hydrosilicates, and the crystals somewhat harder; this indicates in them a molecular texture of coarser nature than is present in the hydrosilicates.

The complex silicates make a fascinating study and certainly a profitable one. Their wide distribution and manifold uses, in cement manufacture, etc., are very good reasons for the continued research on these compounds.

CLEAN MILK, AND HOW TO PRODUCE IT.

THE DANGERS OF IMPURITY.

By W. A. MURRAY, M.B., D.P.H.,
Assistant Health Officer for
the Union of South Africa.

Cow's milk is the most important and most universal of all human foodstuffs. Not only does it enter into the composition of many common articles of diet, but a large proportion of European babies and children are entirely dependent upon it for their nourishment. But milk is the most easily contaminated and, therefore, the most dangerous article of human diet. It forms an ideal medium for the growth and multiplication of many forms of disease germs, such as those that cause enteric fever, dysentry, diarrhœa, tuberculosis, etc., and is able to convey these diseases to human beings with ill-results.

The death-rate of European infants in South Africa is appalingly high, and when the underlying causes are investigated, it is found that a very large proportion of them may be traced to the feeding of infants with impure milk, which sets up fatal bowel diseases.

Many parents who have to use cow's milk for their babies try to ensure its freedom from disease by boiling or pasteurising the raw milk. This practice, however, destroys some very delicate and important properties of the milk; the absence of which in the course of time leads to rickets and other evidence of weakened resistance to the attacks of disease germs. There is no doubt that boiling and pasteurisation very seriously diminish the nutritive and protective value of milk. Every effort should therefore be made to avoid the necessity for the boiling of milk. When watched, the average process of milking, the methods of storage, handling, and distribution of cow's milk in South Africa, it is astonishing how easily and in how many ways the contamination mentioned above can and does occur. It occurs through the addition of *dust* from the cowshed or kraals, *hairs* or *shreds of cow-dung* from the cow, *dirt* or *sweat* from the milker's hands or clothing, *filth and germs* from the feet or mouths or excrement of flies as well as from *bacteria* from unsterilised utensils, bottles, etc., used for milking, or for storing or distributing the milk. Such dirt or bacteria in warm milk rapidly set up fermentative processes, which turn the milk sour and thick,

and may cause very serious bowel diseases in those who consume it.

Yet such contamination occurs daily in most of our so-called "dairies," especially those on farms, in villages, and in the smaller towns. On the other hand, inspection of an up-to-date dairy (and there are, fortunately, a good many to be found in our cities and large towns) reveals the fact that all this contamination can be avoided, and that the production of "pure" milk, and its safe delivery to the consumer, is possible.

· *From the "Journal of the Department of Agriculture.*

·The author gives a series of useful hints which, if followed, will enable the farmer to attain a high standard of purity in the milk produced by him.

CHEMICAL INVESTIGATIONS IN REGARD TO CITRUS.

By Chas. F. Juritz, M.A., D.Sc., F.I.C., Chief, Division of Chemistry.

[Dr. Juritz, several contributions from whose pen have appeared in the *Chemical News*, has been an outstanding figure in scientific matters (notably so in connection with agriculture), in South Africa for many years past. We have just received a copy of a pamphlet (Science Bulletin No. 40, Government Printing Office, Pretoria, South Africa, Price 3d.), embodying an investigation carried out by him in regard to Citrus Culture. The introduction gives some idea as to the nature of the investigation in question.]

Amongst the many branches of investigation undertaken of late years in the chemical laboratories of the Department of Agriculture, those relating to the composition of certain fruits have not been the least important. In regard to the ripening process of grapes, a preliminary series of investigations, undertaken some years ago in the Capetown laboratories, appeared last year in bulletin form. Commencement has been made with a similar series in relation to apricots. At Grootfontein the culture of pineapples has formed the basis of a twofold chemical inquiry, having relation partly to the canning of the matured fruit and partly to the causes of impaired growth amongst pineapples.

The most comprehensive work along this line thus far carried on has been in connection with some of the phases of citrus culture. Of this there are three aspects at present under chemical investigation in the chemical laboratories of the Department, namely :— (*a*) Citrus soils and their fertilisation; (*b*) the composition of the citrus fruit at different stages of its growth, and in different parts of the country; and (*c*) the effects of spraying on the flavour and composition of citrus.

These may be briefly summarised as (*a*) fertilising, (*b*) maturing, and (*c*) spraying.

Trade and General Notes.

ROYAL SOCIETY OF ARTS EXAMINATIONS, 1925.

The Report issued is a record of the varied and useful activities of the above Society. There has been a substantial increase in the number of candidates.

The number of entries for the Society's examinations continues to rise in a satisfactory manner. The number of papers worked this year is 70,88, as compared with 67,282 in 1924, an increase of 8,856. The Report shows how the numbers have grown since 1900, when the figure was under 10,000.

The practical value of the certificates is coming to be more widely recognised every year. A great many of the largest business and industrial firms now directly encourage their employees to enter for the examinations, and grade their junior staffs according to the successes which they obtain.

WORLD'S WHEAT SUPPLY TILL JULY, 1926.

The balance sheet for the period between August 1, 1925 and July 31, 1926, of the International Institute of Agriculture, Rome, deals, on one hand, with an exportable surplus of wheat amounting to about 470 million centals, and, on the other, with the probable requirements of importing countries, forecasted at about 390 million centals. The result is that wheat supplies are more than sufficient to meet consumption requirements, and should leave a good margin in hand at the close of this season.

WHAT THE COAL MINER ACTUALLY EARNS.

The public is always asking what wages are actually earned by the real "miner"—the man who works at the face and gets the coal, as distinct from the surface worker. The speech of Mr. J. Leslie, chairman of the Denaby and Cadeby Main Collieries, at the annual general meeting of the company, in London, on November 2, provides a very interesting answer to this oft-repeated question.

Mr. Leslie informed his shareholders that the average wage per coal-face worker, including fillers, was 17s. 6d. per shift of seven hours throughout the past year, and this, notwithstanding that £46,000 was lost in wages by the coal-face workers through their wilful absenteeism being an average loss of 10s. per man per week.

THE BRITISH INDUSTRIES FAIR.

50,000 Overseas Invitations.

Over 50,000 invitations from the Department of Overseas Trade for the forthcoming British Industries Fair at the White City, London, and Castle Bromwich, Birmingham, are being issued to overseas buyers in all parts of the world during the next few days. This is, of course, quite apart from the very large number of invitations which will shortly be addressed to home buyers.

THE VALUE OF EXHIBITIONS AND FAIRS.

The decision of the Government to revive, next year, the London Section of the British Industries Fair, which was not held in 1925 owing to the continuance of the British Empire Exhibition at Wembley, has already met with a ready response; the large number of applications received for space from British manufacturers all over the country constituting a record. The same can also be said for the Birmingham Section, for, as already announced, the Fair, which will take place from February 15 to 26 next year, is being held in both London and Birmingham.

The number of industrial Fairs which have been organised in various centres abroad within the last few years affords a striking confirmation of the policy of the British Government in instituting the British Industries Fair, which was first held in 1915. Since then no fewer than nine new important Fairs have been established in Europe. In 1917 a Fair was opened at Utrecht and since 1922 this Fair has been held twice a year. In 1920 no fewer than four new Fairs were set up, *viz.*, at Milan, Brussels, Prague, and Barcelona. During 1921, Fairs were opened in Vienna and Riga, and in 1922 Fairs were established at Reval and Zagreb.

CLAUSTROPHOBIA: CAUSE AND CURE.

By Fredk. Wm. Alexander, L.R.C.P. (Edin.)., M.R.C.S. (Eng.)., D.P.H.

(Medical Officer of Health of Metropolitan Borough of Poplar.)

Dislike and dread of travelling in Tubes or Underground Railways is often expressed by people suffering from nervous strain, overwork, etc.

There exists a condition of introspection, *i.e.*, looking inward, contemplating one's own mental processes. These symptoms, real and imaginary, dreadful as they are, receive no sympathy from the sufferer's friends, who cannot understand these morbid feelings. The overcrowded state of trains add their quota to the already strained nerves.

In these days of strain when, as mentioned previously, people expend more nervous force and energy than they can well afford, it becomes imperative to assimilate a large amount of Lecithin, or organic phosphorus, and to obtain this necessary Lecithin to re-build the attenuated nerve cells and to restore their normal vitality and energy, a large quantity of ordinary food would have to be consumed. This means that the excess of food would lead either to deposit of superfluous tissue, or would undoubtedly be the cause of various diseases through undue functioning. This difficulty is eliminated by the administration of Lecithin or organic phosphorus, for Lecithin is a food and not a drug; it is the active principle of nostrums used for the cure of neurasthenia.

Let us therefore combine in our endeavours to abolish underground offices, work places and work-shops, overcrowding in tubes and trains, the latter a hot-bed for disease during the rush hours! establish more open places and playgrounds, shorter hours and more play for brain and sedentary workers; let our people avail them-

selves to the utmost of the benefits of the "Daylight Saving Act," so they may be restored to an A.1. standard by "looking-out"!

Summary from "The Medical Times.

JOINTLESS FLOORS.

A Bulletin* on Jointless (Magnesium Oxychloride) Floors, by P. W. Barnett, A.R.I.B.A., and B. Bakewell ,M.A., is the first of a new series of Building Research publications describing, so far as possible in terms which will not assume specialised technical knowledge on the part of the reader, the results of investigations carried out at the Building Research Station and elsewhere bearing on the scientific problems of the building industry.

The present Bulletin is divided into two parts. Part I summarises in a convenient form existing information on magnesium oxychloride cements in general. Part II describes how, by the substitution of ferrous chloride for magnesium chloride in the mixing, an oxychloride cement is obtained which, while retaining all the usual properties of such cements, has the important advantages that it will not corrode metal work.

For both the normal and the special non-corrosive types of floor, specifications are suggested including tests for the materials required.

* Bulletin No. 1 of the Building Research Board of the Department of Scientific and Industrial Research, published by H.M. Stationery Office, price 1s. net.

FOOD INSPECTION DECISION 196. SAUERKRAUT.

(*U.S.A. Department of Agriculture.*)

The following revised and amended definition and standard for sauerkraut was adopted by the Joint Committee on Definitions and Standards, composed of representatives of the United States Department of Agriculture, the Association of American Dairy, Food and Drug Officials, and the Association of Official Agricultural Chemists, at its meeting, July 13 to 17, 1925.

Sauerkraut is the clean, sound product, of characteristic acid flavour, obtained by the full fermentation, chiefly lactic, of properly prepared and shredded cabbage in the presence of not less than two per cent (2%) nor more than three per cent. (3%) of salt.

It contains, upon completion of the fermentation, not less than one and one-half per cent. (1.5%) of acid, expressed as lactic acid. Sauerkraut which has been re-brined in the process of canning or repacking, contains not less than one per cent. (1%) of acid ,expressed as lactic acid.

The foregoing definition and standard is adopted as a guide for the officials of this department in the enforcement of the food and drugs act.

MR. HENRY FORD AND SCIENCE.

Mr. Henry Ford, not contented with his achievements in the motor industry, has now turned to science and prophesy. While close to Longfellow's wayside inn (Mass.) recently, he talked to and at those present in prophetic tones.

"See that bunch of berries" he said, "that's where the fuel of the future is going to come from; from fruit like the sumach or from apples, weeds, sawdust, almost anything! There's fuel in every bit of vegetable matter that can be fermented. People who say liquid fuel will give out when the crude oil supply gives out, don't know what they're saying. We're coming to the time when we'll grow our own fuel!"

He paused a minute and looked for further illustrations. "Take that field over there," pointing to the potato field behind the Inn. "There's enough alcohol in one year's yield of an acre of potatoes to cultivate the field for 100 years!"

BUILDS NEW, OLD-TIME GRIST MILL.

Balancing himself on an oaken beam in the new grist mill he is having erected not far from the inn, Mr. Ford, earlier in the interview explained how its big waterwheel will work.

"Everything is of stone and steel," he pointed out. "The walls are three to four feet thick. I'm going to have even this oak beam replaced with material that will last longer. Can't have it wear out, you know; it's not a question of just 20 or 50 years here when the old inn itself is 250 years old? I'm building this mill," he added with satisfaction, "to last as long as the Inn does."

From discussing the power which this grist mill will develop, Mr. Ford turned to the kind of energy which he visions the American cities of the future will be using for their light and heat.

"It will be electricity," said Mr. Ford. "I think that's what we're going to use more and more in place of coal. The

anthracite coal strike, which affects the east now, makes that question of big importance. Why, we heat my son's home up in Maine with electricity right now, from radiant heaters. Of course, that through the spring and fall and not in the winter months. But the same thing could be done all the year round for a state like Georgia, where the winter is mild."

GENERATE HEAT UNDERGROUND.

Asked if he thought coal would be converted to electric power at the pit mouth and sent direct to consumers, Mr. Ford exclaimed :

"Why at the pit mouth? Why not burn the coal underground and send it to the city from there without ever bringing it to the surface? That's what they'll do in the future. No, I don't think alleged lack of rivers or lakes for condensing the steam will hold back the change."

THE MEETING OF SCIENCE AND ART.

In medicine, two aspects -namely, those of science and art- meet; at their extremes they are clearly distinct, but their mutual boundary is untraceable. As to what science is and what art is, let me take refuge in saying that all definition is notoriously difficult and that comparisons are odious. Bandaging, I think, I have seen in some hands an art and not a science, and yet in others both an art and a science; and possibly in others a science but without art. Science pursues knowledge for the sake of knowing the how of a result. Perhaps Art uses knowledge for the sake of a result without caring about the how. Science has laws, which ,unlike some laws, are unbreakable. Hence Mr. Bateson's wise advice, "Cherish your exceptions." In Nature's every seeming exception is but obedience to another law. With Art laws are on another plane - even in the fine arts. The laws of the romantic school of yesterday were not the laws of the classical school of the day before. The laws of the Cubists to-day will not be the laws of the Futurists, perhaps Polygonists, of to-morrow. Hence medicine which has become scientific is more stable than medicine which has not. Fashions of bandaging may change, but the principle of asepsis abides. Science and art dovetail in medicine; that is the real point of importance, not any impossible attempt to distinguish them minutely. Art, where skilfully efficient, unconsciously adopts measures science would endorse. And it is a mistake to suppose, as seems sometimes done, that the divisions between science and art in medicine correspond with division between the laboratory and the ward.

Sir Charles Sherringham, O.M., M.D. (Camb.) in the "Lancet."

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Thursday, November 5, 1925, at 4.30 p.m.

Among the papers read were the following :

Observations on Spinal and Decerebrate Knee-Jerks, with Special Reference to their Inhibition by Single Break-Shocks, by L. BALLIF, J. F. FULTON, AND E. G .T. LIDDELL. Communicated by Sir Charles Sherrington, P.R.S.

Simultaneous mechanical torsion-wire myograph and electr'cal records have been obtained of knee-jerks in decerebrate and spinal preparations, and their normal characteristics analysed, as showing the characteristics of their inhibition by single break shocks. The following are the chief conclusions :

1. The spinal knee-jerk differs from the decerebrate. (1) The mechanical response of the spinal jerk is two to three times longer in duration than that of the decerebrate jerk (or the motor twitch). (2) The curve of relaxation of the spinal jerk is characterised by a less steep but smooth decline, while the decerebrate jerk relaxes at first with a speed approaching that of a motor twitch, until it reaches approximately "half-relaxation," when a "hump" appears (postural after-discharge). (3) The electrical response, though apparently single, tends to me more prolonged in the spinal knee-jerk. (4) The latency, *i.e.*, the interval between the tap and the electrical response, is greater in the spinal preparations (8.8 σ) than in the decerebrate (6.6 σ). (5) The spinal jerk is more difficult to elicit than the decerebrate.

2.—We infer that the shortest spinal knee-jerk observed is produced by a repetitive discharge of at least 4 to 8 volleys of impulses recurring somewhat asynchronously at 100 to 200 per sec.

3. Both spinal and decerebrate knee-jerks may be inhibited by a single ap-

propriately times break-shock applied to an ipsilateral afferent nerve.

4. The jerk of a spinal preparation, however, is much more readily inhibited than a decerebrate, the effect of a single break-shock lasting 1 to 3 seconds.

5. When recovering from an inhibition, the spinal knee-jerk has the same duration as a twitch or a decerebrate knee-jerk.

6. In two knee-jerks of equal size (*i.e.*, tension) but different shape, the largest electrical response is observed in that in which the point of inflection of the mechanical ascent is lowest, and in which the point of inflection of the "angle" is sharpest.

Muscular Exercise, Lactic Acid, and the Supply and Utilisation of Oxygen. Part XIII. The Gaseous Exchanges of Restricted Muscular Exercise in Man, by K. Furusawa. Communicated by Professor A. V. Hill, F.R.S.

1.–The gaseous metabolism has been studied for a type of exercise involving only a limited amount of the musculature of the body.

2. For this purpose a simple ergometer, capable of being worked at any speed by the arms, has been constructed.

3. The oxygen required to perform a given amount of work varies with speed at which work is done. There is a marked optimal speed.

4. On the other hand, with constant speed and varying lead, oxygen requirement rises as a linear function of work done, and there is no optimal load.

5. Oxygen intake rises much more slowly to its maximum value than it does in case of exercise involving most muscles of the body, *e.g.*, running or "standing-running." Oxygen intake may be still rising rapidly after six minutes of exercise.

6 Corresponding to this the oxygen-requirement curve diverges at quite low speeds from the oxygen-intake curve, while a large oxygen debt may be set up by a few minutes' exercise involving only a small fraction of total musculature of body.

7.—These facts indicate that lactic acid produced in excess by violent activity of a localised group of muscles may diffuse from them into the blood, and thence to other parts of the body (particularly resting muscles and liver), and there be removed or restored to glycogen under influence of oxidation occurring in those tissues.

8.—There appears therefore to be possibility of an exhaustion due to complete using up of lactic-acid precursor, when the exercise involved is localised in a small group of muscles. The function of the circulation in distributing the fatigue-product (lactic acid) to other organs which are themselves at rest seems an extremely important one, from point of view of vigorous activity of local groups of muscle .

A Spirometer method of Studying Continuously the Gaseous Metabolism of Man during and after Exercise, by K. Furusawa. Communicated by Professor A. V. Hill, F.R.S.

A new method is described of studying continuously the rapidly altering gaseous metabolism of man during and after muscular exercise. A spirometer of large capacity is used, the gases inside is being kept continuously stirred, the total ventilation being measured every 10 litres, and samples being abstracted at intervals for analysis. Various examples are given. Results are obtained similar to those by other methods, but involving considerably less labour.

The Effect of Light on the Circulation, by D. T. Harris. Communicated by Prof. E. H. Starling, F.R.S.

Irradiation of a localised area of skin with ultra-violet energy causes a widespread peripheral vaso-dilation. Consequently, only a very slight transitory rise of blood-pressure results from the small increase in pulse rate of from two to five per minute in dark and white subjects respectively. The reaction was always less in pigmented subjects.

The vaso-dilator response to ultra-violet radiation is enhanced by a previous exposure; this is not the case with radiant heat. The vascular response appears to be a nervous reflex initiated by a nocuous stimulus, and the whole phenomenon one of incipient injury.

The Surface Tension Theory of Muscular Contraction, by A. V. Hill, F.R.S.

1.—It is possible, from two independent sets of data, to calculate the amount of lactic acid ligerated when a muscle fibre 1 cm. long develops a force of 1 dyne. The mean value found is 1.46×10^{-11} grm. This is very nearly 10^{11} molecules.

2.—The area occupied by this number of lactic acid molecules, if spread out in a

continuous mono-molecular film, is about 2.1×10^{-4} sq. cm.

3.- If the mechanical response of muscle were due to a change of surface tension caused by a film of lactic acid, the coefficient of surface tension required would be about 4,800 dynes per centimetre. This is about 280 times the tension of a water-olive-oil interface, clearly an impossible value.

4.—Other reasons are given for regarding the surface-tension hypothesis of muscular contraction in its simple form as untenable.

5.—The lactic acid liberated in a maximal contraction of a frog's muscle in good condition, if spread out in a continuous mono-molecular film would occupy an area about equal to that of the surface of the ultimate fibrils.

6.—Reckoned per gramme of muscle, the amount of lactic acid liberated in a maximal contraction of a frog's muscle is about 0.033 mgr., which would occupy an area of about 470 sq. cm.

Electrical Responses of Extensor Muscles during Postural (Myotatic) Contraction, by J. F. Fulton and E. G. T. Liddell. Communicated by Sir Charles Sherrington, P.R.S.

Simultaneous mechanical and electrical records have been obtained of the responses of quadriceps femoris and rectus femoris of decerebrate cats to various forms of postural (myotatic) reflex, and the following are the chief conclusions :--

(1) The knee-jerk (decerebrate preparation) set up by a tap of less than 1σ duration differs from a motor twitch in five respects :—(*a*) The point of inflection from concavity to convexity usually occurs higher in the mechanical ascent of a knee-jerk than of a twitch; (*b*) the plateau is of longer duration; (*c*) the "angle" is less sharp and is followed by "nose"; and (*d*) the tital duration of knee-jerk is greater than the twitch and more variable; (*e*) the electrical response always has a higher point of inflection and is more spread out. From this we conclude that the knee-jerk is produced by a somewhat asynchronous volley of impulses.

(2) An extensor muscle of a decerebrate preparation shows no vibration of the de Barenne-Buytendijk type in the string when completely inhibited (Einthoven) or when the tendon is detached so that the muscle is completely flaccid. When the tendon is extended by a force of 100 to 400 or more grammes the vibration occurs.

(3) During a stretch reflex in which 4 to kilos active tension are developed, the string may be almost completely quiet, save for a slight de Barenne-Buytendijk vibration at the height of the response. If, however, the stretch is applied discontinuously, as when stretching table falls irregularly, or when tendon is tapped during stretch, well-defined action currents occur at an interval 6-7 σ after the irregularity or tap. We conclude from this that the comparative absence of electrical responses in stretch reflex is due to complete asynchronism of afferent stimuli, for when a large number are recruited synchronously an action current invariably occurs.

(4) Since, as Sherrington has pointed out, the exaggerated stretch reflex characteristic of the decerebrate condition is in large measure responsible for rigidity of extensor muscles in the decerebrate animal, we have inferred that these sustained postural reactions are produced by asynchronous all-or-nothing contractions of individual muscle fibres rather than by hypothetical fixing mechanisms.

On the Supposed Pluri-Segmental Innervation of Muscle Fibres, by L. N. Katz. Communicated by Professor A. V. Hill, F.R.S.

The finding of Cattell and Stiles has confirmed that in the frog, when the two components of the sciatic nerve are stimulated in succession in an isometric tetanus, the sum of the tension developed is considerably greater than the tension produced when both components are stimulated simultaneously. Their claim that this indicates that the majority of the muscle fibres in the gastrocnemius are innervated from more than one spinal segment is criticised. An alternative explanation is suggested, based on the fact that the resultant of two forces is not necessarily their sum.

A crucial test was applied to the theory of pluri-segmental innervation by repeating Cattell and Stiles' experiments, employing the heat production as a criterion of the number of muscle fibres activated. Heat has no directional quality, and the deflections obtained should be simply additive, provided that the contraction is isomeric and the initial tension constant.

The total heat developed on stimulating the two components of the sciatic nerve separately is the same, within experimental error, as the heat produced when they are stimulated simultaneously. Th's indicates that there is no pluri-segmental innervation of frog's muscle fibres apart from possible infrequent chance variations.

ROYAL SOCIETY OF ARTS.

At meetings after Christmas the following papers will be read: "Investigations in Agricultural Science at Rothamsted," by Sir John Russell, F.R.S.; "Religions and Races in the Punjab," by Sir Michael O'Dwyer, G.C.I.E., K.C.S.I. (Sir George Birdwood Memorial Lecture); "The Work of the Imperial Institute," by Sir Richard Redmayne, K.C.B.; "Women and Children in Indian Industries," by Lady Chatterjee: "Some General Problems of Fruit Preservation," by Professor J. McLean Thompson; "The Propagation of Electric Waves," by Mr. . E. Taylor; "Problems in Paint and Varnish Technology," by Dr. H. Houlston Morgan; "Domestic Heating," by Dr. Mary Fishenden; "Modern Views of Vitamins," by Professor J. C. Drummond; "Horse Traction and Motor Traction," by Mr. James Paterson; "Indian Maps and Surveys," by Colonel W. M. Coldstream, C.I.E., and "The New Delhi," by Mr. Herbert Baker, A.R.A., F.R.I.B.A.

Courses of Lectures will also be delivered by Mr. H. P. Shapland, A.R.I.B.A., on "Ornament in Furniture"; by Dr. G. W. C. Kaye, on "The Production and Measurement of High Vacua"; by Mr. W. F. Higgins, on "Thermometry"; and by Mr. C. R. Peers, C.B.E., Director of the Society of Antiquaries, on "Ornament in Britain."

SOCIETY OF GLASS TECHNOLOGY.

The first meeting of the Society of Glass Technology for the Session 1925-26, was held in Sheffield on October 21, when the president, Mr. T. C. Moorshead, delivered his presidential address on "The Glass Bottle Industry and its Future Developments."

At the outset, Mr. Moorshead pointed out that the comparative lack of definite knowledge of the structure and characteristics of glass and the means of controlling its manipulation with absolute certainty had to a large extent retarded the development of the mechanical phases of the industustry. Yet the last quarter of a century had seen practically a complete revolution in the manufacture of glass containers, and this period formed one of the most important epochs in the history of the glass bottle industry, economically, scientifically, and commercially.

About 1900, two ideas, totally different in principle, suddenly blossomed forth. One was Homer Brooke's idea of feeding a machine with a stream of glass flowing by gravity from the furnace. The other was the application of the suction principle in feeding the machine, a process developed by M. J. Owens. From this time, progress in the development of mechanical devices for glass manufacture had been rapid. With the development of automatic processes there had come a very great improvement in the character of all of the auxiliary plant and equipment, with the result that to-day many bottle manufacturing plants were practically mechanically operated throughout.

Future developments in the gravity process and in the suction process depended on different factors. The success of the suction process lay in its application to mass production, but it was not economically adaptable to the smaller units. With the gravity flow process it should be possible, on account of the comparatively simple auxiliary plant required for feeding, to produce articles more economically and at the same time to obtain the desired flexibility of operation.

After dealing briefly with lehrs, including "heatless" lehrs, Mr. Moorshead went on to discuss furnace design, a subject which had been very much neglected. Properly co-ordinated research work, exploring the problem thoroughly, would no doubt be rewarded with valuable information. In the firm belief in the feasibility of the principle of feeding and melting the batch at the same time, and with a view to blazing the trail for future and more extensive research work, the United Glass Bottle Manufacturers, Ltd., were arranging to finance some experimental work based on the principles outlined by Mr. Alex. Ferguson, and described to the Society of Glass Technology in May, 1923. Details of the proposed experiments were given; the theoretical advantages claimed for the new process being (1) smaller radiating surface per ton of furnace melting capacity, the

ratio being approximately 2 to 1; (2) more intimate contact between the flame and the constituents of the batch. The first-mentioned, however, depended upon (a) the feasibility of melting the batch, when pulverised and fed into the furnace in fine powder, in the short time of passage through the flame; (b) the corrosive effects of the stream of molten glass on the side walls of the funnel-shaped melting chamber, as well as the effect on the glass itself.

In conclusion, the mechanical development of the bottle industry in the past twenty years had been little short of marvellous, and in mechanical efficiency was probably not surpassed by any other manufacturing industry. Nevertheless, still further research was necessary to discover a formula from which it would be possible to produce a glass with more stable characteristics than that with which they had to deal to-day. Further knowledge of the mechanical properties of glass would also assist in opening up new fields or markets which had heretofore been untouched, and considered outside of the domain of the glass manufacturer.

A discussion followed.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Paper read on November 10, 1925.

The Determination of Unsaturateds in Petroleum Spirit, by W. R. ORMANDY, D.Sc., F.I.C.F.C.S., AND E. G. CRAVEN, (Members).

(EXCERPT.)

As has been pointed out in a previous note (*J. Inst. P.T.*, 10, 41, 1924), the term unsaturateds in connection with petroleum spirit has a restricted meaning. The term is confined to those hydro-carbons containing one or more double bonds which absorb bromine readily under the conditions of the usual tests such as those of Hanus or Wij. It is some of these constituents which give rise, in cracked spirit in particular, to sticky resins. It may very well be, as Dr. Dunstan points out, that gum formation is due to bodies of the diene class and not to mono-olefines. Certainly such of the liquid mono-olefines, as have been prepared in a state approaching purity, appear to be very clean distilling bodies, quite suitable for use at motor fuels. Moreover, by suitable processes of purification, spirits have been obtained which, while having high bromine absorptions, yet do not deposit gum on standing or give resinous residues in the copper dish test.

No satisfactory method appears to have been devised for the determination of the proportion of unsaturated hydrocarbons present in a given sample of petrol. The present note does not claim to offer any solution of the problem, except as indicating that if several methods lead to substantially the same figure, then some reliance may be placed on the result.

The main ideas in this work were as follows. Firstly, assuming the unsaturateds present to be mono-olefines, each molecule should absorb 2 molecules of bromine. If, therefore, the molecular weight and the bromine absorption of the unsaturateds were known, an estimation could be made of the proportion of unsaturateds present. Secondly, if from the total loss in strong sulphuric acid the aromatic content were abstracted, the difference should be the unsaturateds.

As compared with distillation without vacuum, the advantages of high vacuum distillation may be summarised as follow:

Economy in fuel oil consumption, about 50 per cent.

Extra yield in distilling, about 4 per cent.

Extra yield in refining ,about 4-6 per cent.

Saving of sulphuric acid, 50-75 per cent.

It has been proved beyond question that in every instance all products possess better physical properties; safety in operation is greater, as, due the vacuum, leakages cannot occur; repairs are practically never necessary.

In every instance these advantages have covered the total capital outlay in less than one year.

I feel that it is for the technical man a source of great satisfaction to have worked long and arduously for a good idea. I believe I may regard myself as a pioneer in this, a sphere formerly known only to the laboratory chemist. High vacuum plant will soon not be found missing in the modern refinery.

In conclusion, my sincere thanks to Dr. A. E. Dunstan for the willingness with which he undertook to read this paper, a kindness which has enabled me—prevented from reading it personally by pressing business affairs to respond to the invitation with which the Institution of Petroleum Technologists has honoured me and to place my views before its members.

THE INNER STRUCTURE OF ALLOYS.

By Walter Rosenhain, D.Sc., F.R.S.

(Cantor Lecture, Royal Society of Arts, March, 1925.)

Abstract.

" We have now to consider the question of the conduction of electricity through metals. The theory of electrical conduction in metals in a subject about which physicists still considerably disagree, but they agree, at any rate upon this point, that electrical conduction consists in the passage of electrons through the metal. These electrons are the minute particles of negative electricity which can exist in the free state. We see streams of them in the cathode ray discharge of a vacuum tube, and in other manifestations. They exist as a kind of satellite to the positive nucleus in the atom, and it is believed, although it has never been proved, that in addition to these electrons which are attached to the atoms in a metal, there are also a number of free electrons. The effect of applying an electric field is to generate in a metal in a conductor a flow of electrons. The rate at which the electrons move need not be the rate at which the electric current passes through the conductor. If we apply an electromotive force to a conductor, however long, the effect at the far end makes itself felt after a time, which is measurable in terms of the velocity of light. We know that the electrons cannot move through the metal at that rate. It is a question of electrons being pushed in at one end, and a corresponding number being pushed out at the other end, the electrical stress being transmitted with the velocity of light. What the exact mechanism is by which that transmission occurs, and how those electrons behave, exactly, we do not yet know. There are certain difficulties about nearly every theory which can be advanced. One of the earliest theories, and the most prevalent, is that the metal behaves, so far as the free electrons are concerned, as if it were an empty space, and that the electrons move about in it as the molecules of a gas move about inside a closed vessel, and that if additional electrons are pushed in at one end the increased pressure results in a corresponding number being expelled at the other. That seems quite plausible until one looks into the figures, and then it is found that the number of electrons required to carry the current is so great that the other properties of the metal would not fit in with it. The specific heat of the metal would have to be far higher that it really is in order to allow of an adequate number of free electrons. Lindemann has put forward a modification of that view in supposing that between the atoms of the metal in the lattice of the crystal is an independent lattice of electrons, and that when additional electrons are put in at one end by the application of electromotive force, the lattice bodily moves and a corresponding number are expelled at the other end, so that each electron has moved only one interatomic distance. Unfortunately, it can be shown mathematically that an electron lattice between the atoms would be unstable and could not exist. There are other objections also. However that may be, the fact remains that electrons must in some way or other travel through, or rather communicate their motion through, the crystals of the metal, and it at once suggests the idea that where the crystal of the metal consists of atoms perfectly regularly arranged on a lattice, the passage of those electrons through that lattice, either through the atoms or between them (we do not know which is it), will be very little, if at all, impeded by the atoms; but where the atoms are not in line, where they are out of line, either through thermal oscillation or through the distortion of the lattice by the presence of atoms of another kind, there the motion will be impeded, and part of the energy of that motion will be dissipated as heat.

NOTICES OF BOOKS.

Hexosamines and Mucoproteins, by P. A. Levene. The Rockfeller Institute for Medical Research, New York. Price 10s. 6d. net. Longmans, Green and Co., 39, Paternoster Row, London.

This excellent monograph deals with many subjects, not, of course, exhaustively, which would be impracticable in a single volume, but still sufficiently so to bring out the results of the latest investigations. The properties of simple sugars and numerous acids are dealt with in detail, and there are given numerous methods of various authors, which very materially enhance the value of the work. The Bibliography and references are extensive, while the alphabetical index is sufficiently full for easy reference.

Skinner's Cotton Trade Directory of the World, 1925-26: A World Book of Reference.

The book is greatly enlarged as compared with its predecessor, being 2,400 pages as compared with 1,400 pages- an increase of 1,000 pages. It aims, as its title denotes, at being the Cotton Trade Directory of the world, and although the book is only in its third year of issue, marked success has already been secured. It is difficult with a book of this size to accurately visualise its contents. So we would point out that the particulars embrace companies, firms, and individuals in the world, no matter in what country they reside, with the result that information has had to be sought and obtained from every known cotton centre, be it in one of the fore-most countries concerned with the cotton industry, or ,say, in Cuba, Cyprus, Syria, Peru, or Zanzibar.

As to details there are upwards of 80,000 entries, each, where possible, accompanied by the necessary data, so that a mass of information, not hitherto collated and published, is to be found in one volume. For instance, particulars are given of 8,400 exporters, merchants and brokers; 10,500 spinners and manufacturers; 8,000 directors and managers (British only); 2,500 yarn doublers, bleachers, dyers, etc.; 3,500 yarn agents, merchants, exporters; 3,000 piece goods dyers, finishers, etc.; 6,000 piece goods agents, merchants, exporters, etc.; 300 fabrics, more especially as to the latest types of novelty fabrics, with over 20,500 names of manufacturers of same; 600 artificial silk (Rayon) producers, manufacturers, doublers, dyers, agents, etc.; 400 artificial silk (Rayon) machinists; 1,300 mill supplies articles with 16,500 names of makers of same.

In order to facilitate reference it should be noted that :—

1. All contents, prefaces, indices, headings are printed in English, French, German, Spanish, Italian and Portuguese.
1. The book is copiously sub-divided into its various sections arranged in the same sequence as occurs in the operation of the trade itself, with name "tabs" so that each individual section is plainly discernible to the user.

The book is handsomely bound in green cloth, with gold lettering, and is published at what can only be described as a modest price, namely, 25s. (post free, 26s.), the aim of the proprietors being to produce a reference book of the world's cotton trade embodying information on every one of the many interests into which that trade is divided and at a price which is within the reach of al land everyone. It can be had from the proprietors, Gresham House, Old Broad Street, London ,E.C.

The Production of Precious Stones during 1924, by GEORGE FREDERICK KUNZ, Sc.D., Ph.D., A.M. (Reprinted from Mineral Industry). McGraw Hill, Book Company, 370, Seventh Avenue, New York.

Production of Platinum for the Year 1924. Same author and published as above.

CONTRIBUTIONS FROM THE LABORATORIES OF MESSRS. MURPHY AND SON.

We are in receipt of Bulletin No. 14, 1925, which contains contributions from the above well-known firm of Mortlake London, and also Leeds and Nottingham.

The present issue contains an article by F. A. Mason on "The Effects of Pressure on Yeast Cells," with some remarks thereon. The author concludes: "It is known that carbon dioxide at a pressure of 50 atmospheres retards the growth of bacteria in water, and will steralise it in 24 hours. Is it not possible that pressure, plus the action of carbonic acid gas with which the liquid is charged and in which the cells are immersed during pressure in our brewery practice, is at the root of the difficulty sometimes realised in the use of pressed yeast?

"Production of Sound Beer with the Minimum of Preservatives," by George Jones; and "P_H Value and the Use of the Comparator in Brewing" (in which are given numerous interesting formulæ) by F. A. Mason, are other informative contributions in the same issue.

FORTHCOMING EVENTS.

THE FARADAY SOCIETY.

Ordinary Meeting, Monday, November 16, 1925, at 8 p.m., in the Rooms of the Chemical Society, Burlington House, London, W.1.

Papers to be read.

"A Chemical Theory of Remanent Magnetism," by E. D. CAMPBELL.

"An Improved Form of Electric Vacuum Furnace," by J. R. PARTINGTON AND N. L. ANFILOGOFF.

"A Source of Error in the Mechanical Aanlysis of Sediments by Continuous Weighing," by J. R. H. COUTTS AND E. M. CROWTHER.

"A Simple Method of Obtaining the Size Distribution of Particles in Soils and Precipitates," by DONOVAN WERNER.

"Co-ordination and Co-Valence," by J. A. V. BUTLER.

"Adsorption by Charcoal from Alcohol-Benzene and Acetone-Benzene Mixtures," by F. G. TRYHORN AND W. F. WYATT.

"The Nature of the Interfacial Layer between an Aqueous and a Non-Aqueous Phase," by F. L. USHER.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology will be held in the Lecture Theatre of the Coal, Gas and Fuel Industries Department, The University, Leeds, on Wednesday, November 18th, 1925, at 2.30 p.m.

Several important papers will be communicated.

JUNIOR INSTITUTION OF ENGINEERS.

Annual General Meeting, Friday, 13 November, at 39, Victoria Street, at 7 p.m.

Lecturette, "De-Hydration of Tar," by G. E. Wills, assoc. Member Friday, 20 November, at 39, Victoria Street, at 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.

Ordinary Meeting in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C.2., on Thursday, 19 November, 1925, at 6 p.m. (Light refreshments at 5.30 p.m.) "The Engineer: His Due and His Duty in Life," by Mr. T. Carter.

ROYAL STATISTICAL SOCIETY.

November 17, at the Rooms of the Royal Society of Arts, John Street, Adelphi, Mr. G. Udney Yule, M.A., F.R.S., etc., "Why We Sometimes Get Nonsense-Correlations Between Time Series."

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

PEROXYN.

460,908.—Chemical substances prepared for use in medicine and pharmacy. -E. T. Pearson & Co., Ltd., 35, Golden Square, London, W.C.1. October 21st, 1925.

SEXIGENE.

461,379.- A medicine for human use.—Stephen Matthews & Co., Ltd., 19, 20, & 21, Farringdon Street, London, E.C.4. October 21st, 1925.

459,604.- Label device bearing the words, "VITALITY PIPS," and William Ford Freeman, for chemical substances prepared for use in medicine and pharmacy, but not including pastilles for the cure of coughs, colds and bronchitis, or any goods of a like kind to these.—Williams Ford Freeman, 70, Kennington Park Road, London, S.E.11. October 21st, 1925.

BISERIRTE.

461,644.—Chemical substances prepared for use in medicine and pharmacy. —Bismag, Ltd., 7, Wybert Street, Munster Square. London, N.W.1. October 28th, 1925.

W. HUDSON.

462,308.—Chemical substances prepared for use in medicine and pharmacy. —Walter Hudson, The Lumley Pharmacy, Lumley Road, Skegness. October 28th, 1925.

EUVOX.

462,648.—Chemical substances prepared for use in medicine and pharmacy. —Pasmore Cassidy, Ltd., 98, Mortimer Street, London, W.1. October 28th, 1925.

Publisher's Announcements.

The following Books can be obtained from Rea & Inchbould, Merton House, Salisbury Square, London, E.C.4.:

CONFESSIONS OF GREAT SOULS,

By the REV. J. E. ROSCOE, M.A.

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Various numbers, parts of Vols. 117 and 118 (1918/19) are only on sale at 2s 0 1 each.

THE GENERAL INDEX TO VOLS. 1 to 100 can still be purchased at £1 1s. (CARRIAGE PAID.)

All communications should be addressed to the MANAGER, CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

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EKA-CAESIUM AND EKA-IODINE II.

By F. H. LORING AND J. G. F. DRUCE.

In our communication dealing with the above elements (this Journal, Nov. 13, 1925), owing an an error in connecting the data in paragraph 1 with the original crude oxide, the statement made is perhaps misleading. As a matter of fact, the experiment was on the sample from pyrolusite (*loc. cit.*, paragraph 4); but the lines given were, as implied, on a different film to that of the one mentioned in paragraph 4. The reader has only to bear this in mind, and delete all reference to rhenium (dvi-manganese) as no lines of this element appeared on the first film from the sample made from pyrolusite.

On the other film, we should mention that a very faint line of wave-length 1.428 was observed, which is evidently the Lα line of rhenium. The Lβ line of this element did not apear on the film, as is often the case when the α line is very faint. This is perhaps to be expected, as the sample was purified with a view of obtaining more eka-caesium. The difficulty of effecting proper separations in cases of this kind is very considerable, and we prefer not to express any decided view on this point.

On the film referred to in paragraph 1 of the previous communication, there were two indistinct lines not of very good definition, of wave-lengths 0.895 and 0.693. The former we associated with Lβ line of eka-iodine, the latter we here associate closely with the Lβ line of element 93; moreover, the former (0.895) would also be closely associated with the Lα line of the suspected element of atomic number 93. Thus it will appear that the Lα and Lβ lines of the highest member of the manganese group are foreshadowed, but they are too ill-defined for us to establish their identification with this possible element. On the film referred to in paragraph 4 (*loc. cit.*) there was an unidentified line of wave-length 0.900, which was mentioned in our previous communication. The error in these cases may be taken as one-half of one per cent.

In conclusion, we should explain that the two films referred to above are not really comparable, owing to the faintness of the lines on one (the first mentioned) and owing to the rather strong Br-Ag absorption "band" and other darkening on the second film. Wherever we have associated two lines (α and β) with a given element, they have been on the same film.

AN ELECTROLYTIC METHOD FOR THE DETERMINATION OF ZINC IN ZINC ORES.

By ROBERT E. SULLIVAN AND HIRAM S. LUKENS.

Up to the present time no entirely satisfactory electrolytic method for the determination of zinc in zinc ores has been worked out. In view of this fact, the following work was undertaken with the idea of either improving the old methods, or substituting something better.

In 1908, Dr. Harrison Hale offered a thesis to the faculty of the University of Pennsylvania on "An Electrolytic Method for the Determination of ine in Zinc Ores." *His method seemed to work very well for *pure* zinc blende, but results on poorer ores were not so concordant nor reliable. His work formed a basis for this investigation.

At first it was thought advisable, in order to save time, to make an effort to extract the zinc without filtering from the gangue. The finely powdered ore (.3 to .5 gm.) was fused in a small nickel crucible with 20 gm. of sodium hydroxide for about 30 minutes, and after cooling, the melt was taken up with water and transferred to a platinum dish, which acted as anode. For the cathode, a nickel crucible was attached to the shaft of a motor by means of a rubber stopper. The zinc solution was then heated to about 70° C., and the crucible rotated at a rate of about 500 r.p.m. Five determinations were made in this way, but in all of them a considerable amount of gangue contaminated the zinc deposit. The results were as follows :—

* *Chem. Abs.*, 2, 2354.

No.	Blende	Dilution	Amp.	Volt	Time	Temp.	Zinc	% Zinc
1.	.298	120 c.c.	1.1	3.5	65m.	60	.1656	55.88
2.	.3003	130 c.c.	1.5	1.0	45m.	80	.1670	55.61
3.	.3037	140 c.c.	11.0	4.0	50m.	90	.1710	56.30
4.	.2037	150 c.c.	7.0	5.0	50m.	70	.1150	56.41
5.	.5001	300 c.c.	7.5	5.0	65m.	70	.1776	55.58

In Nos. 1 and 2 the deposit was uniform, but very dark and spongy. The current was increased, and at a current density of 7 to 8 amperes and 5 volts, a beautiful, adherent, crystalline deposit was obtained. Higher current densities did not improve the deposit.

Since the gangue material found its way to a swiftly rotating cathode, it seemed unlikely that any method could be devised which would prevent its deposition or occlusion. Therefore, in the next determinations, the solution of the melt was filtered through a Gooch crucible before electrolysis. This operation only took a very few minutes, so that the element of time was very little affected. In fact, filtering has one advantage in that the residue on the Gooch crucible can be tested to see whether the fusion is complete. The test first used was to moisten the residue with cobalt nitrate solution and oxidise it with a flame from a blow-pipe. A green colouration (Rinmann's green) shows the presence of zinc. The following determinations were made, using two platinum anodes (area of each, 60 sq. cm.), suspended in a 600 c.c. beaker, which contained the zinc solution. A nickel crucible (volume 10 c.c.) was used as cathode, rotating at a rate of 500 r.p.m.

No.	Blend gm.	KOH gm.	Dilution c.c.	Amp.	Volts	Time min.	Zinc gm.	% Zinc
6	.5015	25	250	7.0	5.5	60	.2630	52.44
7	.5001	25	250	7.0	5.5	60	.2455	49.09
8	.3014	15	250	7.0	6.0	60	.1580	53.42
9	.3016	25	375	7.5	4.5	60	.1547	51.29
10	.1585	15	300	7.0	6.0	50	.0781	50.05

In Nos. 9 and 10 the size of the beaker was changed to one of 850 c.c. capacity, and the solution diluted to about 350 c.c. This gave a better deposit and also cut down the bubbling during electrolysis. However, it was evident from the wide variance in the results that something was wrong, although every sample was carefully tested, both for zinc in the residue on the Gooch crucible (the cobalt nitrate test), and for zinc in the electrolyte. The latter test was made by withdrawing about 10 c.c. of the electrolyte, acidifying with HCl, and adding a few drops of potassium ferrocyanide. A white precipitate, $Zn_3K_2[Fe(CN)_6]_2$, shows the presence of zinc. No zinc was found in any of the above samples.

In the next sample, instead of testing the residue on the Gooch crucible with cobalt nitrate, it was taken up with concentrated HCl, boiled with a few drops of HNO_3, and the iron precipitated with ammonia and filtered. After acidulating the filtrate with HCl, potassium ferrocyanide was added, and a positive test for zinc was obtained. This seemed to indicate that the cobalt nitrate test is not always reliable, but to make sure, other samples were tried, in which the residue on the Gooch crucible was divided into two parts. One part was tested with cobalt nitrate and the other with potassium nitrate and the other with potassium ferrocyanide. In every case the former gave a negative, and the latter a positive test for zinc.

The electrolytic determinations were now stopped and all efforts bent toward effecting a complete decomposition of the ore. First the time of fusing was lengthened, and the temperature during fusion increased but without improvement. Then a little potassium nitrate was added to the fusion, it being thought that oxidation of the sulphur would aid in the decomposition, but zinc was still found in the residue. Sodium peroxide was also tried without successs.

At this point, the fusions were stopped, and the finely powdered sample of mineral was decomposed with nitric acid. After heating for a few moments on a water bath,

the solution was diluted to about 25 c.c., and an excess of caustic potash added. The solution was then filtered through a Gooch crucible and washed with hot water. The residue was dissolved in concentrated HCl, the iron reprecipitated with KOH, and filtered; but zinc was still present in this second residue on the filter. In the next sample, instead of reprecipitating the iron with KOH, ammonium hydroxide was used. This time no zinc was found in the residue, and several other samples were tried with the same result. Electrolytic determinations were again started, adding the second filtrate to the first. The presence of ammonia in the electrolyte did not seem to affect the zinc deposit.

Procedure.

A brief summary of the procedure is as follows: Place about .3 to .4 grams of the finely powdered mineral in a small casserole, and add just enough water to moisten the sample thoroughly. Cover the casserole with a watch glass. Lift the glass a little and allow 10 c.c. of concentrated nitric acid to run in from a pipette. Place the dish on a water bath and heat for five minutes. Then dilute the solution to about twice its volume. Dissolve 20 grams of KOH in 100 c.c. of water, and add an excess of this to the nitric acid solution. Filter the reddish-brown precipitate, together with the gangue and sulphur, through a Gooch crucible and wash thoroughly with hot water. Transfer the filtrate from the filter flask to an 850 c.c. beaker, and add to it the rest of the KOH solution, which was not used to precipitate the iron. Replace the filter-flask and pour about 10 c.c. of HCl in the Gooch crucible. Allow to stand two or three minutes, then start the suction and wash all of the acid through the Gooch crucible to the flask. Transfer this acid solution to a beaker, add a few drops of nitric acid and boil. Reprecipitate the iron with ammonia and filter. The same crucible can be used for all three filtrations without changing the asbestos mat. Add the filtrate from the iron to the first filtrate and dilute the whole volume to aproximately 350 c.c. Heat to about 65 c., but *do not boil*. Place two platinum anodes (total area about 120 sq. cm.), in the solution, and suspend the rotating cathode (a 40 c.c. nickel crucible) so that the solution comes about one centimetre from the rim of the crucible. This exposes about 30 sq. cm. of cathode surface to the electrolyte, and leaves ample room for handling the crucible after electrolysis. Then pass a current of 8 amperes through the solution. This will require a potential of 5 or 6 volts. Wash down the sides of the beaker several times during electrolysis. In about 45 minutes, remove about 5 c.c. of the solution with a pipette, make slightly acid with HCl, and test for zinc with potassium ferrocyanide. If no zinc is present, wash the solution in the beaker free of the electrolyte, using a siphon to withdraw, and distilled water to replace the electrolyte as fast as it is withdrawn. Be careful to keep the zinc deposit covered with the solution during the washing. When the ammeter shows that no current is passing, turn off the switch and remove the crucible. Wash carefully with alcohol and ether, dry and weigh.

The following results were obtained in sequence :—

No.	Blende gm.	Dil. c.c.	Amp.	Volts	KOH gm.	Time min.	Temp. C.	Zinc gm.	% Zinc
11	.3004	350	8.0	5.5	20	50	70	.1632	54.32
12	.3008	350	8.0	5.0	21	50	70	.1635	54.44
13	.3002	450	8.0	5.5	20	50	75	.1628	54.28
14	.3008	400	8.0	5.2	20	45	70	.1630	54.27
15	.3005	350	8.0	5.0	20	45	80	.1632	54.31
16	.3017	350	8.0	5.0	20	45	70	.1641	54.39
17	.3000	350	8.0	55.0	21	50	70	.1626	54.20
18	.3001	350	8.0	5.0	20	45	70	.1630	54.31
								Average ...	54.309

A volumetric analysis of the sample gave the following results :—

(a) 54.38 % Zinc.
(b) 54.29 % Zinc.

Average ... 54.335 % Zinc.

A new portion of ore was finely ground, and the following determinations made, using samples which varied in weight:

No.	Blende gm.	Dil. c.c.	Amp.	Volts	KOH gm.	Time min.	Temp. C.	Zinc gm.	% Zinc
19	.3530	350	8.0	5.2	20	45	70	.1903	53.90
20	.2505	350	8.0	5.5	20	40	65	.1346	53.73
21	.6522	350	8.0	5.0	27	60	65	.3514	53.87
22	.4099	350	8.0	5.5	25	50	65	.2202	53.72
23	.5008	350	8.0	5.0	25	55	65	.2695	53.81
								Average ...	53.806

Volumetric analyses of this sample gave the following results:

(a) 53.64 % Zinc.
(b) 53.82 % Zinc.

Average ... 53.73 % Zinc.

All gravimetric and volumetric methods for the determination of zinc are not only long drawn out, but require considerable practice to carry them out successfully. The electrolytic method outlines above can be carried out in about 2½ hours, but by overlapping, one analysis can be turned out every 70 minutes.

Notes on the Procedure.

1.- Care should be taken not to add too much caustic, as this causes a bubbling which proves very annoying.

2. Be careful not to boil the solution of potassium zincate, as this causes hydrolysis, throwing down insoluble zinc hydrate.

Comparison of this Procedure with the Fusion Process.

1.—The alkali fusion can only be used for very rich ores unless the residue on the filter is dissolved in acid, and the iron re-precipitated as above.

2.—The alkali fusion consumes much more time than the decomposition with nitric acid. The caustic must first be melted, the water expelled, and the melt allowed to cool. Then the ore is added and fused for 15 or 20 minutes, and this is allowed to cool and then taken up with water. This part alone will require at least 45 minutes, while nitric acid will accomplish the same thing in five minutes.

3.—The rotating cathode is much easier to handle than the nickel gauze and other forms of stationary cathode, especially when washing with alcohol and ether.

4.—The rotating cathode causes good circulation of the electrolyte, especially in the neighbourhood of the cathode ,thus favouring an even, crystalline, adherent deposit of zinc.

5. It is much more convenient to use a large beaker to hold the electrolyte than a small nickel dish, for in the latter case great care must be exercised to keep the volume low. The increased dilution also stops bubbling during the electrolysis.

6. By this method there is not even a trace of iron in the zinc deposit. In the alkali fusion there is always a chance that some of the iron will not be converted to the insoluble oxide, and this is then deposited on the cathode with the zinc.

Contribution to the "Chemical News" from the John Harrison Laboratory of Chemistry, University of Pennsylvania.

THE ELECTROLYSIS OF LEAD AND TIN ORES.

By Robert Saxon, B.Sc. (Vict.).

Galena is a most difficult problem in ionization, being insoluble in dilute acids, sulphides, chlorides, hydrates, sulphates, carbonates, nitrates, and if, as Waller says, soluble in sodium thiosulphate, it is very sparingly so, certainly not sufficiently so for electrolysis. Ammonium nitrate and galena intimately mixed when electrolysed give a deposit of the metal, but not sufficiently good to be of any use whatever for isolation purposes. There is more lead sulphate than lead. An appreciable amount of oxide is formed. Sodium nitrate gives negative results, as do sodium chloride, ammonium chloride, ammonium hydrate, alkaline carbonates, or sodium acetate. The last-named gives a faint deposit of the oxide, the first step towards isolation, but no metal. A mixture of ammonium sulphate and ammonium chlor

ide gives a faint deposit of the metal. Potassium hydrate makes most impression on galena, but not sufficient to warrant its use commercially. Dilute nitric acid acts under the ionizing influence of the electric current with much greater rapidity than anything else yet tried. A mixture of the acid and ferrous sulphate is better still.

The carbonate of lead, in the form of cerussite, phosgenite or white lead, the first being carbonate only, respond fairly readily to electrolysis when mixed with ammonium nitrate, sodium nitrate, calcium nitrate, or barium nitrate. Caustic alkali or lime assists the reaction considerably. Sodium or ammonium acetate does not at all respond well, the resistance to the current causing heat to be developed, and consequent reddening and disintegration of the acetanion.

Cotunnite, the chloride of lead, yields the metal with water, much more readily with a few drops of nitric acid, but less readily with hydrochloric acid, or sulphuric acid. Ammonium nitrate does not materially help the deposition, though *it is stated* that lead chloride is soluble (easily) in ammonium nitrate and water. This latter statement the author does not agree with. Matlockite and mendipite, oxychlorides of lead yield the metal less readily than the chloride, but give abundant quantities of the oxide. Fused lead chloride is very stubborn and not at like the precipitated chloride, just as galena is entirely different in its behaviour towards nitric acid to the precipitated or synthesised sulphide. Minerals seem to have been produced under conditions not at all favourable to ionization. The specific gravity of lead is about 11.3, of sulphur 2.0, and of galena is 7.5. Cotunnite, the chloride of lead, has a specific gravity of 5.52, cerussite has a specific gravity of 6.51, both lower than that of galena.

Tinstone, or cassiterite, almost the only ore of tin, the dioxide, gives good deposit of the metal, clinging to an iron cathode tenaciously and evenly when mixed with ammonium sulphate, sodium sulphate, or potassium sulphate, and electrolysed. Its specific gravity is 6.95, that of the metal being 7.3. The action may be represented thus:—

Sn Cathode -- — $SnSO_4$

with H_2SO_4 - - Anode —- SO_3 and O

The H_2SO_4 reforms, and is formed in the first instance from the sulphate used and water by electrolysis. (In this notation, action is represented as taking place from the centre on either side, the metal proceeding to the left, and the anion to the right. New associations are supposed to form from anion like SO_4, and cation like H_2, round about the word "with.")

Cassiterite gives a generous crop of tin, compactly and evenly laid on the cathode, when mixed with, first a very dilute solution of hydrochloric acid to clean the cathode or iron, and then sodium chloride, or the chlorides of ammonium or potassium. The anode is of lead, which remains bright throughout.

EFFECT OF WEAR AND TEAR ON THE MAGNETIC PROPERTIES AND TENSILE STRENGTH OF STEEL WIRE.

By Ramond L. Sanford, Walter L. Cheney, and James M. Barry.

(U.S.A. Bureau of Standards.)

The work here described is part of a more extended investigation on non-destructive methods of testing wire rope. In order to design intelligently apparatus for the non-destructive testing of wire rope it is necessary to know the nature and magnitude of the effects involved. One of the causes of deterioration in wire rope is wear, and this paper is a description of the work done to determine the effect of wear on the magnetic properties and tensile strength of steel wire of the type used in the manufacture of wire rope.

It was found that wear increases the magnetic permeability for low values of magnetising force and decreases it for higher forces. This effect is similar to the effect of stress, though much less in magnitude, and is attributed to a redistribution of internal stress. This change in magnetic properties is accompanied by an increase in tensile strength.

Summary and Conclusions.

To recapitulate briefly: (1) Apparatus was constructed which reduced the area of cross section of steel wire by wear over a length of about 60 cm. with satisfactory uniformity.

(2) Observations were made to determine the effect of reduction of area by wear

upon the magnetic properties and tensile strength of the wire.

(3) It was found that the effect on the magnetic properties, though much smaller in magnitude, was of the same nature as that of tensile stress, namely, an increase in permeability in the lower range of magnetising force and a decrease in permeability for higher values of magnetising force.

(4) The results indicated an increase in tensile strength per unit area with reduction in area, amounting to about 7 per cent. for a reduction in area of 50 per cent.

From these results it was concluded that :--

The effect of wear on magnetic properties is due to a redistribution of internal stresses.

With regard to the disturbing influence of wear on the results of magnetic exploration for the detection of flaws, since this effect is of the same nature and of much less magnitude, it can be treated in the same way as the effect of stress, namely, by making tests at properly chosen values of magnetising force.

Trade and General Notes.

FUEL RESEARCH BOARD REPORT.

The Department of Scientific and Industrial Research has just issued the report of the Fuel Research Board for the period ended 31 December, 1924, together with the report of the Director of Fuel Research, which enters into fuller details. As this is the first general report on the work that has been issued since 1920, it includes a history of the organisation and a summary of the whole of the work carried out (details of much of which have already been published), as well as an account of that in hand and projected.

The subject is dealt with under the following headings :

(i) Physical and Chemical survey of the National Coal Resources; (ii) Work in Connection with the Gas Industry; (iii) Low Temperature Carbonisation; (iv) Steam Raising; (v) Internal Combustion Engines; (vi) Power Alcohol; (vii) Peat; (viii) Domestic Heating; and (ix) Laboratory and Miscellaneous work.

Appendices give lists of all official publications on Fuel Research issued by the Department and of the chief publications on the subject by members of the Staff, or by individuals assisted by the Department; also lists of the Fuel Research Staff and of Committees, and the conditions under which the Staff undertakes tests of low temperature carbonisation plants.

The report may be obtained from the Stationery Office.

CANADIAN HONEY PRODUCTION.

An estimated production of 15,804,000 lbs. of honey, with a value of 2,552,000 dollars, is reported by the Dominion Bureau of Statistics covering the year 1924, states the Agent-General in London for the Province of Quebec.

PREVENTION OF COAL DUST EXPLOSIONS.

A paper on "Stone Dust as a Preventative of Coal Dust Explosions Comparative Tests," by G. S. Rice and R. V. Wheeler (Safety in Mines Research Board Paper No. 18, H.M. Stationery Office, Adastral House, Kingsway, London, price 8d. net), has just been published. This paper is an outcome of the arrangement for co-operative research made between the Safety in Mines Research Board and the United States Bureau of Mines, details of which have been given in the annual report of the Safety in Mines Research Board for 1924.

Until quite recently, the Bureau of Mines of the United States of America and the Safety in Mines Research Board (which has continued, *inter alia*, the investigations of the Explosions in Mines Committee of the Home Office) have worked independently, and have arrived at aparently different conclusions regarding the amount of stone dust which must be mixed with coal dust in order that the mixture shall be incapable of propagating flame when raised as a cloud in the air. In order to obtain a direct comparison of the results of the experiments carried out at the Experimental Mine at Bruceton, Pennsylvania, and at the Experimental Station at Eskmeals, Cumberland, tests have now been made with a standard British Coal (Altofts Silkstone) and a standard American coal (Pittsburg) at the American Testing Station, and again, with the same coals, at the British

Testing Station, under the conditions prevailing at each station, respectively.

To the British mining engineer the most important conclusion drawn from these two series of comparative tests (which are described in the present paper) is that the behaviour of the American and British coals, selected as standards, is sufficiently uniform under similar conditions of testing to render available for direct application to British coals the results of the numerous series of experiments made with the Pittsburg coal at the Experimental Mine in America in order to gauge the effect of such factors as the degree of fineness of the dust and the direction of the ventilation currents.

THE PROSPERITY OF THE UNITED STATES.

Colonel The Hon. Vernon Willey, and Mr. Guy Locock (Federation of British Industries), have just issued a report of their recent visit to the U.S.A., which shews not only that the U.S.A. is a great country, but that it is in a very prosperous condition, as the following excerpts shew:

"Everyone knows of the wealth of the United States, but it is to be doubted whether it is fully realised in Great Britain how overwhelmingly vast that wealth is to-day. The following figures show the percentage of American production or resources as compared with world production and resources in certain commodities or services:

	American percentage of total world production or resources. %
Coal production	48.5
Petroleum production	71.9
Copper production	52.7
Pig-iron production	60.2
Steel ingots and castings production	59.8
Wheat production	21.8
Cotton production	52.0
Lumber production	52.0
Automobiles registered	82.7
Telephones and telegraphs ...	57.8
Railroads	38.9
Rubber consumption	70.9

When one considers that these percentages of production or ownership apply to a country whose population, large as it is, formed in 1922 only 6.2 per cent. of the total population of the world, it is easy to grasp what a high level of individual prosperity is enjoyed by the U.S. That prosperity extends through all classes, and we would give the two following examples at different ends of the social scale. Last year 74 people in the U.S. had net incomes of over £200,000. Turning to the working classes, we noticed, when visiting a garage in Washington, that there were over 50 Fords and similar cars parked round it. We learned that these were the private cars of taxicab drivers, practically all of whom drive to their work in the morning in their own private car. Another good index of the prosperity of the nation is to be found in the return of the savings banks, which have doubled in the last seven years.

CONCLUSIONS.

In conclusion, we would draw attention to the four points which most struck us during our visit to the United States:—

1. The amazing prosperity of the United States, which shows every sign of continuing.
2. The greatly increased efficiency of production, and the increasing competition which we must expect from the United States in the world markets.
3. The general belief that prices in the United States are not likely to rise in the near future.
4. The regrettable misapprehension in the minds of the American public of what the real state of affairs is in Great Britain.

ON THE ARRANGEMENT OF THE MICRO-CRYSTALS IN ROLLED PLATINUM PLATE.—PART I.

By SHINSUKE TANAKA.

ABSTRACT.

By means of X-rays the arrangement of the micro-crystals in rolled platinum foil was tested by the powder method on one hand, and by taking photographs of the X-ray spectra caused by the reflection of the rays from the surface of the foil on the other hand. The X-ray patterns thus obtained were explained by the following consideration:—The greater part of the micro-crystals in the foil are so aranged that their dodecahedral face is parallel to the surface of rolling and the normal to a trapezohedral face, which is contained in the dodecahedral face just considered, is parallel to the

direction of rolling; and consequently the trigonal axis in the same dodecahedral face, which is perpendicular to the direction of rolling in the rolled surface. The orientation of some of the micro-crystals deviates slightly from such ideal orientation.

(*Memoirs, College of Chemistry, Tokio University.*)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Thursday, November 12, 1925, at 4.30 p.m.

Among the papers read were the following:-

The Structure of α and β Quartz, by SIR WILLIAM BRAGG, F.R.S., AND R. E. GIBBS.

The original investigations upon α quartz, whilst determining many of its features, left four unknown parameters, *viz.*, the distance of the silicon atoms from the trigonal axis and the spatial relations of the oxygen to the silicon atoms. One parameter could be estimated from the results of intensity measurements, but more data were required.

At 578° α quartz undergoes a transition to the β hexagonal variety and a careful examination of the accompanying changes of many of its physical properties pointed to the transformation being a small one from the structural point of view. If, therefore, the β structure could be determined that of the α would become nearer solution.

In determining the β structure, it was possible first to settle the position of the silicon atoms, and then to limit the oxygen atoms so that only one unknown parameter remained. The evidence of theoretical calculations and of X-ray rotation photographs of quartz above its transition point was sufficient to evaluate this last unknown. The structure shows that the oxygens surround the silicon atoms tetrahedrally, and that the spirals parallel to the principal axis are formed by alternate atoms of silicon and oxygen. Atomic dimensions are consistent with the normal values and the structure agrees with requirements.

All the varied types of twinning of both β and α quartz are fully discussed; they follow from the model and furnish a confirmation of it. the structure is consistent with the development of pyro and piezoelectricity and compatible with the theory of electrical conductivity.

The Light of the Night Sky: its Intensity Variations when Analysed by Colour Filters. II., by LORD RAYLEIGH, F.R.S.

This paper recapitulates, with small correction, and continues the series of observations of the night sky in England initiated in *Roy. Soc. Proc.*, A, Vol. 106, p. 117, 1924. The series now extends over nearly two and a half years. As before, the intensities of the various chromatic components of the light are found to undergo important variations when measured against a fixed terrestrial standard. These components also undergo considerable relative variations when measured against one another.

For extreme ranges so far encountered are:

For the auroral component (region near λ5578)	4.7 to 1
Blue component	2.6 to 1

Attention is primarily concentrated on the spectral region transmitted by a screen designed to isolate the green auroral line as nearly as possible. Notwithstanding the definite relative variations, this auroral intensity is rather highly correlated with the intensity in the orange-red region, not quite so highly with the blue region, and still less, though quite definitely, with the photographic region centred near λ4800.

The values found for the corelation coefficients are:

Aurora-red, 0.70; Aurora-blue, 0.66; Aurora-photographic, 0.44.

On the other hand, the auroral intensity is not correlated appreciably with the degree of magnetic disturbance or the height of the barometer. The connection of the sun-spots, if any, is not yet apparent.

The intensity does not vary measurably with the sun's distance below the horizon, within the limits, evening and morning, when twilight is excluded.

when twilight is excluded.

Parallel observations of the auroral intensity over some months have been made by Mr. H. D. Babcock, at Pasadena, and at Mt. Wilson, California. The values there are in the mean more than double those prevailing in England.

ROYAL SOCIETY HONOURS.

The following awards have received Royal approval :-

Royal Medals.—Professor W. H. Perkin, F.R.S., for work on the constitution of the alkaloids; and Professor A. C. Seward, F.R.S., for researches on the palæobotany of Gondwanaland.

The following awards have also been made by the President and Council :—

The Copley Medal to Professor A. Einstein, Foreign Member R.S., for his theory of relativity and his contributions to the Quantum Theory.

The Davy Medal to Sir James Irvine, F.R.S., for his work on the constitution of the sugars.

The Sylvester Medal to Professor A. N. Whitehead, F.R.S., for his researches on the foundations of mathematics.

The Hughes Medal to Mr. F. E. Smith, F.R.S., for his determination of fundamental electrical units and for researches in technical electricity.

The following is a list of those recommended by the President and Council for election to the Council at the anniversary meeting on November 30 :

President, Sir Ernest Rutherford; *Treasurer*, Sir David Prain; *Secretaries*, Mr. J. H. Jeans and Dr. H. H. Dale; *Foreign Secretary*, Sir Richard Glazebrook.

Other Members of Council. Professor J. H. Ashworth, Professor L. Bairstow, Professor F. O. Bower, Professor S. Chapman, Sir Dugald Clerk, Professor F. G. Donnan, Professor E. J. Garwood, Professor J. P. Hill, Professor J. B. Leathes, Professor J. C. G. Ledingham, Sir Thomas Lewis, Professor F. A. Lindemann, Sir Robert Robertson, Sir Charles Sherrington, Dr. G. C. Simpson, and Mr. W. C. D. Whetham.

MINERALOGICAL SOCIETY.

Among the papers read at the meeting on November 3 (Professor W. W. Watts presiding), were the following :-

The Dissociation of Dolomite, by C. S. Garnett.

Further evidence is put forward in support of conclusions adduced in a previous paper that true dolomite dissociates under the influence of heat in a single step and not in two stages as formerly supposed. The setting of semi-burnt dolomite with water is due to free lime and not to a mixture of magnesium oxide and calcium carbonate.

A New Refractometer, by B. J. Tully.

The special features of this new refractometer are thorough rigidity and an exceptionally large and flat field of vision due to the long optical system employed, the shadow edges being straight instead of curved, as in older types. All adjustments for focussing, lighting, etc., being independent of the main body which contains the optical system and graticule scale in a dust-proof enclosure, little damage is possible by inexperienced usage.

Notes on Some New British Localities for Barytocalcite and Alstonite, by A. Russell.

The occurrence of barytocalcite at the following new localities is described :— Ayleburn Mine, Northumberland, 2 miles north of Alston, where is occurs abundantly and well crystallised with blende in brown limestone; Heartycleugh Mine, West Allendale, Northumberland, in small quantities with barytes; and Lolly Scar Mine, Nidderdale, Yorkshire, massive and in small crystals with fluor, chalcopyrite, witherite, etc. Alstonite, massive and in crystals of the usual habit, was found as a single specimen in the witherite vein worked in Ushaw Moor Colliery, near Durham.

The Meteoric Iron of Vaaubult and Meteoric Stones of Witklip and Queen's Mercy, South Africa, by Dr. G. T. Prior.

A mass of meteoric iron weighing 26 lbs. was found on Vaalbult Farm, Prieska Division, Cape Province. It is a coarse octahedrite, having a percentage of nickel of about 7, with a ratio of iron to nickel of about 13. The Witklip stone fell on May 26, 1918, on the farm Witklip in Carolina district, Transvaal, after a loud explosion and a flash of light. It is a grey chondrite resembling Cronstad. Only a few grams appear to have been preserved. The Queen's Mercy stone is also a grey chondrite, which fell on April 30, 1925, about 20 miles from Matatiele, Cape Province, after appearance of a bright light and a loud detonation. The stone, which measured about 1½ feet in length, was broken up by the natives, and only a few fragments have been recovered.

JUNIOR INSTITUTION OF ENGINEERS.

Flow Meters.

In the course of a lecturette delivered before the Institution on November 6, at 39, Victoria Street, London, on the subject of "Flow Meters," Mr. W. H. Simmons, A.I.C., described a type known as the Rotameter, which has come into prominence recently. The instrument consists of a vertical transparent tube, tapering towards the lower end and containing a float which is kept suspended by the upward flow of liquid or gas which is being measured. The height of the float in the tube indicates directly on a scale marked on the tube the rate of flow. There are several grooves on the outside of the float so that the stream of liquid or gas keeps it in rapid rotation.

Mr. Simmons said that the Rotameter was accurate to within 2 per cent., due to the fact that it was entirely frictionless. There was no wear or deterioration over long periods. Rotameters were used in many industrial processes, for instance, for the control of chlorine for water purification, and for many purposes in gas works. It was used also for the mixing of gases in correct proportions.

In the discussion which followed the lecturette, questions were asked regarding distant recording and integrating venturi meters, and meters for measuring a pulsating flow.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the meeting held on Friday, October 23, 1925, at the Imperial College of Science. F. E. Smith, C.B.E., F.R.S., President, in the chair.

The Influence of Strain on the Thomson Effect, by H. E. Smith, B.Sc., Birkbeck College, University of London.

The influence of tension on the Thomson effect in wires has been investigated by Nettleton's method. For pianoforte steel, charcoal iron, constantan and nickel, the Thomson coefficient numerically decreases with tension until the elastic limit is reached, after which it increases. With removal and restoration of tension a new definite cycle is followed. The Thomson effect in tungsten, here measured for the first time, increases with tension and also follows a cycle. No change in the Thomson effect is noticed in brass or German silver. Heterogeneity was not present in the specimens investigated.

The Measurement of Temperature by Thermocouples in Unequally Heated Enclosures, by W. Mandell, B.Sc.

In measuring temperature by thermocouples in unequally heated enclosures it is shown that the recorded temperature depends upon the thickness of the couple, the nature of the walls of the enclosure and the nature of the gas. An explanation is suggested based upon the fact that the amount of radiation received and emitted by a couple depends upon its position in that enclosure, and that the amount of energy transferred to it by molecular impact varies with the nature of the gas.

On the Flashing of Certain Types of Argon-Nitrogen Discharge Tubes, by W. Clarkson, M.Sc., read by the Assistant Secretary, in the absence of the Author.

The paper gives an account of investigations of the flashing of discharge tubes having various types of electrodes, and in which the filling gas, a mixture of argon and nitrogen, had a wide pressure range.

It is shown that the observations are in general agreement with those obtained previously on neon and air discharge tubes, minor differences between tubes being discussed, and that at higher pressures the discharge was no longer of the "glow" type, but took place between definite points on the electrodes.

A discussion followed in each case.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the monthly meeting on November 4, held at the offices, 16, Bedford Square, London, W.C.1., Mr. Ludington, chairman, reported that the consulting chemist had submitted a list of the samples analysed by him for members during the months of August, September and October.

Further consideration had been given to the question of the amendment of the Fertilisers and Feeding Stuffs Act, and Dr. Voelcker had stated that he understood that a draft Bill had been prepared.

Dr. Voelcker had reported that he had drawn up on behalf of the Central Association of Valuers a revised table of the values of unexhausted manures and feeding stuffs. This had been adopted by the Association and issued.

The Committee had considered matter for inclusion in "Occasional Notes," in which slight alterations had been made. The consulting chemist had reported that a satis-

factory settlement had been arrived at in the case of a member whose cattle had been poisoned by cake containing castor oil bean.

Various other matters arising out of his correspondence had been submitted to the Committee by Dr. Voelcker.

The paragraphs relating to the Chemical Department in the draft general meeting report had been approved.

THE INSTITUTE OF MINING AND METALLURGY.

The second ordinary general meeting of the thirty-fifth Session was held, by kind permission, at the Rooms of the Geological Society, Burlington House, Piccadilly, London, W.1., on Thursday, November 19, 1925, at 5.30 o'clock p.m.

The following papers were submitted for discussion :

The Influence of Superimposed Strata on the Deposition of Certain Lead-Zinc Ores, by Robert A. Mackay, Student.

Economic Geology and the Mining Industry, by H. C. Boydell, Associate.

FARADAY SOCIETY.

The Electron Affinity of the Halogens, by E. B. Ludlum, D.Sc.

(A contribution to a General Discussion on "Photochemical Reactions in Liquids and Gases," held by the Faraday Society, at Oxford, October 1 and 2, 1925.)

Abstract.

The emission of an electron from an atom of sodium vapour takes place when the atom receives a quantity of energy just in excess of that which corresponds to the limit of the principle series in its spectrum. The measurement of this wave-length fixes accurately the ionisation potential of the metal. When the electrons return to the atoms they may do so with a wide range of kinetic energy and the resulting spectrum commences where the principle series finished and extends continuously towards the shorter wave-lengths, gradually fading away.

A similar continuous spectrum exists, no doubt, for electro-negative elements, but lies much further in the ultra-violet, and could only be photographed in a vacuum grating spectrograph. Even for iodine, the least electro-negative of the halogens, light in the Schumann region is necessary in order to produce ionisation.

The importance attaching to the ionisation potential in the case of the alkalies is transferred, in the case of the halogens, to the *electron affinity*, the energy emitted on acquiring an electron as contrasted with the energy gained on losing one. In both cases it is the energy of formation of an ion from a neutral atom. There is at present no direct method of determining electron affinity, although its importance in photochemical change is obvious, for when a hetero-polar molecule, such as hydrogen. chloride, is formed from its elements, the electron jumps from the electro-positive to the electro-negative atom.

Although no direct determination has been made, the value for the electron affinity can be deduced.

(*a*) By considering a cycle of changes, starting from the crystal of the alkali halide, separating the + and − ions, taking the electron from the halogen and restoring it to the metal allowing two of the halogen atoms so neuthalised to associate forming a molecule and allowing this to act on the condensed vapour of the metal, thereby returning to the crystal state. Accepting Born's value for the lattice energy the only unknown is the electron affinity, which will therefore be the algebraic sum of all the other energy changes in the cycle.

(*b*) By using the lattice energies as deduced from heats of solution by Fajans.

(*c*) By using Foote and Mohler's values for the ionisation potential of the halogen hydrides.

(*d*) A fourth method, suggested originally by Franck, is to calculate the value from the electron affinity spectrum, if one can be found. This is the problem.

Continuous emission spectra can be produced in the case of the halogens. The first to be examined was that of iodine, and recently, in addition, those of bromine and chlorine have been studied by Steubing, Gerlach and Gromann, ourselves, and others.

(Our own interest in the question arose some years ago in planning to repeat the experiments of Haber and Just on the emission of electrons when halogens act on sodium or mercury. We were inclined to believe that the emission was a secondary, photoelectric, effect caused by the radiation emitted by the halogen on receipt of an electron from the metal. The emission spectra for bromine and chlorine were not known at the time and we proceeded to look for them, being chiefly in the ultra-violet they had escaped observation previously.)

There are two continuous bands for each of the three halogens, and they are displaced towards longer wave-lengths with increasing atomic weight. They can be excited in an ordinary discharge tube, but we preferred to use silica tubes and external electrodes. The head of the bands is on the long wave-length side and they fade away towards the ultra-violet. Increase of temperature increases the intensity of the band of higher frequency and diminishes that of the other; accordingly, the latter was assigned to the molecule and the former to the atom. Wood had found that the longer wave length band, in the case of iodine, was weakener by reducing the pressure and as this condition favours the presence of atoms rather than molecules, the evidence is in the same direction. Moreover, the lower band occurs in a region of general absorption, with which molecules are concerned, and the higher one outside such region. It may be regarded as established that the band in the longer wave-length is associated with the molecule.

Unfortunately for the electron affinity explanation of the more ultra-violet band, the evidence that they are associated with atoms is unsatisfactory. That they increase in intensity with rise of temperature is positive evidence, but they are also produced by the action of active nitrogen on the halogens in their ordinary state. The surprising thing, however, about them is that they can be produced by the addition of gases, particularly of nitrogen, to the fluorescing iodine molecule, and Oldenberg showed, further, that they should be resolved into close narrow single bands such as characterise the band spectra of molecules. This observation must be regarded as disposing finally of the hypothesis that this band is an electron affinity spectrum unless some way of escape can be discovered. One such possible opening might be Oldenberg's result that with increase of temperature the single bands fade, whereas the continuous spectrum increases in intensity; it is also quite conceivable that the continuous spectrum overlaps the spectrum of single bands which might be caused by the absorption of the continuous radiation by excited iodine molecules, or collision with them before they have had time to radiate.

Speculations of this nature are not unjustifiable as long as no other satisfactory explanation is forthcoming and as long as no other spectra can be discovered which may more fitly be ascribed to the electron affinity.

Steubing has suggested that a cause of these spectra may be a hypothetical instability in the outer ring of electrons of the halogen atom; Oldenberg argues in favour of the union of positive and negative iodine ions and relies on collisions to remove the excess energy that such a union would provide over and above that required for the radiation; Born and Franck propose tentatively that "quasi-molecules" may conceivably provide a way out of the difficulty, *i.e.*, molecules which have not settled down from a state of unquantised energy to that of definite molecules.

It remains all the more remarkable, if these are not electron affinity spectra, that the energy change underlying the phenomenon should agree so well with the calculated electron affinity and that the falling off in the intensity towards the ultra-violet should closely resemble that of the continuous spectrum of the alkali metals.

		1st Band		2nd Band	
			Energy Kilo.		
Halogen		λ, $\mu\mu$	Cals.	λ	Energy
Cl	...	320	89	265	107.5
Br	...	370	77	295	96.6
I	..	430	66	345	82.3

REFERENCES.

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Angerer, *Z. Physik.*, 1922, 11, 167.

Steubing, *Ann. der Physik.*, 1921., 64, 673.

Gerlach and Gromann, *Z. Physik.*, 1923, 18, 239; *Die Naturwissenschaften*, July 3, 1925.

R. W. Wood, *Researches in Physical Optics*, Part II., p. 51, 1919.

Franck, *Z. Physik.*, 1921, 5, 428.

Franck and Wood, *Verh. deut. Phys. Ges.*, 1911, 13, 84.

Born, *Verh. deut Phys. Ges*, 1919, 21, 13, 679.

Fajans, *Verh. deut. Phys. Ges.*, 1919, 21, 539, 714.

Oldenberg, *Z. Physik.*, 1924, 25, 136; 1925, 31, 914.

Ludlam and West, *Proc. R.S. Edin.*, 1924, 44, 185.

NOTICES OF BOOKS.

The Surface History of the Earth, By JOHN JOLY, Sc.D., F.R.S., Fellow of Trinity College, Dublin. 192 pp., with numerous illustrations, and an Oro-Buttinggraphic chart of the world, shewing areas of volcanic activity, with the ocean "deeps" according to John Murray. Price 8s. 6d. net. Clarendon University Press, Oxford.

The study of the earth's surface is an entrancing one to the thoughtful student, or, in fact, to most intelligent beings. The subject is so wide that to deal adequately with it would require many volumes much larger than that now before review. Dr. Joly manages to cram into a small compass a vast amount of information, told in attractive language. Briefly, the contents are: The Earth's Surface Structure; Isostasy; The Continents and the Substratum; The Radioactivity of the Rocks; the Decipherment of Surface History; The Source of Revolutions; The Building of Mountains; The Revolutions; Geological Time; The Dominance of Radioactivity; Appendices.

While the work is largely scientific, the subjects are dealt with in a way which will be quite within the mental grasp of one of ordinary intelligence, even though his knowledge of science is strictly limited.

The following excerpt is interesting:

"It is enough to say here that the mountain ranges of the earth have been built up out of folded sediments. The mountains have, in fact, risen from the sea are rocks which were slowly deposited in the depths of the seas in comparatively recent times. This fact gives us the clue to the age of the mountains. Clearly the Himalayas must have been lifted up after those beds had been formed. And we have to recognise that where the mountain now stands the sea had once stretched in prehistoric solitude. Age-long accumulations of sediment to depths of thousands of feet--may have been formed before the great resurrection took place. Evidently such great depths of sediment could not have accumulated if the floor of the anciet sea had not been sinking. Because of their great extent, such vast subsiding areas are known as geosynclines. The geosyncline wherein the Cordilleras of North America were cradled extended from the Gulf of Mexico to the Arctic Ocean, and was more that 1,000 miles in width.

It would appear as if six great cycles of world transforming events are recognisable during the course of geological history. In each of these events, the succession of events has been the same. The continents sink relatively to the ocean. The waters flow in over the lower levels and vast areas become covered by trangressional seas. These seas persist over very long periods—fluctuate in area—advance and retreat often many times—but always still advancing until at length a time is reached when retreat overtakes advances, and little by strange climax is attained just where the seas have been most enduring, mountains begin to arise. First it seems as if lateral forces were at work. For the rising deposits the age-long sedimentary accumlations of geocynclines come up crushed, folded, and even over-thrust for many miles. These are destined to form the mountain ranges of the ensuing era. A last great vertical uplift, long after the first deformation of the sediments, raises these new-born mountain ranges high above the continental levels; an uplift which may amount to many thousands of feet. Then succeeds comparative repose. Evidence of cold climatic conditions often attends the period of greatest continental elevation. These conditions finally pass away after some thousands of years, telling of renewed sinking of the land. And this period of slow sinking endures over millions of years, approximating ever more and more to the time when once more the seas shall flood the continents. An so the cycle of events begins all over again."

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Readers are reminded that there will not be any meeting on Thursday, 26 November.

ROYAL INSTITUTION.

The hundredth annual course of Christmas lectures for juveniles at the Royal Institution, will be delivered this year by Sir William Bragg, on "Old Trades and New Knowledge. "The Trade of the Sailor," is the title of the first lecture on Tuesday, December 29, and the five following lectures will be on the trades of the smith, the weaver, the dyer, the potter, and the miner.

THE INSTITUTE OF MINING AND METALLURGY.

The succeeding general meetings of the Session will be held at Burlington House on the following dates (Thursdays):-

December 17, 1925; January, 21, 1926; February 25, 1926; March 18, 1926; April 15, 1926; May 20, 1926.

ROYAL STATISTICAL SOCIETY.

Session 1925-1926.

Ordinary meetings will be held monthly from November to June, in the lecture hall of the Royal Society of Arts, John Street, Adelphi, London, W.C.2.

The chair will be taken at 5.15 p.m., on the following dates (Tuesdays):

November 17, 1925; December 15, 1925; January 19, 1926; February 16, 1926; March 16, 1926; April 20, 1926; May 18, 1926; June 15, 1926.

Visitors may attend the ordinary meetings on the introduction of a Fellow.

JUNIOR INSTITUTION OF ENGINEERS.

39, Victoria Street, London, S.W.

Wednesday, 25 November. Visit to the Headquarters of the London Fire Brigade, Southwark Road, at 3 p.m.

Friday, 27 November, at 39, Victoria Street, at 7.30 p.m. Lecturette, "The Engineer and his Relationship to the Tea Industry," by E. Granville-Smith, Member.

Saturday, 28 November.—Official Visit to the Shiping, Engineering, and Machinery Exhibition at Olympia. (Lecture by T. E. Dimbley, Member, on "Introspection as an Aid to an Industrial Revival," at 3.30 p.m., in the lecture hall of Olympia.)

GEOLOGICAL SOCIETY OF LONDON.

At the meeting on December 2, the following communication will be read: "The Depth of Origin of Earthquakes," by R. D. Oldham, F.R.S., F.G.S.

At the meeting on December 16, the following communication will be read:— "The Black Marl of Black Ven and Stonebarow in the Lias of the Dorset Coast," by Dr. W. D. Lang, M.A., F.G.S., and Dr. L. F. Spath, F.G.S.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

26,088. Badische Anilin & Soda Fabrik. Manufacture of organic compounds containing oxygen. October 19th.

26,248. Cassella & Co. Ges. L. Manufacture of organic phosphorus compounds. October 20th.

26,194.- Chemische Fabrik Griesheim-Elektron. Production of phosphoric acid. October 20th.

26,620. Karpen & Bros. S. Manufacture of methylals. October 23rd.

27,224. Beale, E. S. L. Production of aromatic hydrocarbons by cracking. October 29th.

26,725. Blaydon Manure and Alkali Co. (1887) Ltd. Treatment of phosphatic materials. October 26th.

27,222. Casale, L. Catalytic preparation of alcohols, etc. October 29th.

26,764. Duncan, W. E. Removal of naphthalene from coal gas. October 26th.

Specifications Published.

231,078. Norsk Hydro-elektrisk Kvaelstofakieselskab. Process for the concentration of diluted nitrous gases.

240,955. Badische Anilin & Soda Fabrik. --Synthetic manufacture of methanol and higher alcohols.

220,958. -Austerweil, G. Process for the preparation of thymol from p-cymene.

241,022. Thomson, J. Instrument for use in making graphical analyses and computations.

225,199. Asseev, C. Process for the production of chemically pure aluminium compounds.

218,638. -Terwilliger, C. O. Synthetic resins and process of making the same.

241,266.– Knoll & Co., Chemische Fabrik. —Manufacture of double compounds of dimethulxanthines, earth alkali, and salicylic acid.

241,829. -Lloyd, G. F., and Campbell, F. H. Manufacture of white lead.

231,117. Casale, Dr. L. Catalytic synthesis of ammonia.

221,227. Austerweil, G. Process for the preparation of thymol from p-cymene.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, W.C.2., at the uniform price of 1s. each.

Abstract Published.

289,303. Electrolysis. Lloyd, S. J., Colonial Place University, and Mennedy, A. M., 108, Thorn Place, Cloverdale, both in Alabama, U.S.A.

Arsenates and arsenic, obtaining. A neutral or slightly basic solution of a solution of an arsenite, such as sodium arsenite formed by dissolving arsenic trioxide in caustic soda is electrolysed with insoluble electrodes of iron or other material to form an arsenate. When no diaphragm is used hydrogen is given off at the cathode and a small amount of arsenic is reduced, appearing in the solution as small black particles. By using a two-compartment cell with the arsenite as anolyte, the production of arsenic is prevented, but the electrical efficiency is less. The arsenate solution is filtered, and may be added to a solution of calcium chloride or a suspension of calcium hydroxide to precipitate calcium arsenate. In the latter case sodium hydroxide is produced, which is filtered off and used in the production of more sodium arsenate. Alternatively calcium and lead arsenites may be oxidised in a cell containing sodium arsenite as electrolyte. Calcium arsenate and lead arsenate may be used as insecticides.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

BORAZEL.

451,886.—Medicines for internal human use.—Potter and Clarke, Ltd., 60, Artillery Lane, London, E.1. October 21st, 1925.

GENOXIDE.

458,149. Hydrogen Peroxide for use in banufactures. B. Laporte, Ltd., Kingsway, Luton, Bedfordshire. November 4th, 1925.

HYDROSITE.

461,502.—Hydrosulphite of Soda for use in manufactures.—Stockport United Chemical Co., Ltd., Buxton Road Works, Stockport. November 4th, 1925.

THE CHEMICAL NEWS,

VOL. CXXXI No. 3424.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES:
Administrative: Central 6521.
Printing Works: Hop 2404.

SEARCH FOR ELEMENT No. 93.

PART II. EXAMINATION OF CRUDE DVI-MANGANESE.

By F. H. LORING AND J. G. F. DRUCE.

Introductory.

Whilst our main object the isolation of an element of atomic number 93 - has not, so far, been attained, we have succeeded in isolating appreciable quantities of the oxide of element No. 75 (dvi-manganese). This oxide has been obtained

(1) From "pure" manganese sulphate,
(2) From commercial pyrolusite, and
(3) From "pure" manganese sulphate.

The yields of crude dvi-manganese compounds isolated according to the method outlined in Part I. (this Journal, 1925, CXXXI., p. 273), was as follows:

From "pure"	$MnSO_4$	.075	per cent.
,, ,,	$MnCl_2$	.120	,, ,,
,, crude	MnO_2	.015	,, ,,

The product from manganese chloride was richer in dvi-manganese than the others, whilst that from pyrolusite is now believed to contain eka-caesium, eka-iodine and element No. 93 as well.

In Edmund White's *Analytical Reagents* (1911), p. 53, iron, magnesium and the alkalies, calcium and zinc are given as occasionally present in "pure" manganese chloride and sulphate.

The chloride contained a trace of iron and the sulphate a distinct and determinable amount. The manganese chloride also contained an appreciable amount of calcium, whilst this impurity was almost absent from the sulphate.

From a spectroscopical examination, Hartley and Ramage (*Trans. Chem. Soc.*, 1897, LXXI., 533) concluded that pyrolusite usually contained sodium, potassium, rubidium, silver, copper, calcium and iron; occasionally gallium, indium and thallium were present. They made no mention, however, of magnesium. It seems probable that dvi-manganese, etc., have been confused in the past with magnesium and the alkalis. Neither magnesium nor zinc has been chemically detected in the samples we have used.

The pyrolusite employed contained 85 per cent. of MnO_2 (estimated by the iodine equivalent method) and 9 per cent. insoluble matter (silica or silicates) and about one per cent. of calcium oxide.

The necessity of paralleling the chemical findings by physical analysis by means of X-ray spectra we fully realise, and to this end a table and curve are prepared to show the results so far obtained. The foreshadowings of elements of atomic numbers 85, 87 and 93 are also indicated by the table and curve referred to, which are in support of our previous publications in this Journal (October 30, November 6, 13, 20 of this year). These communications should be consulted in connection with the material here given. We have assigned this section of the research to Part III.

With regard to the X-ray spectra of element 75 the table referred to includes the results from the first samples prepared from manganese sulphate and pyrolusite—films 4 and 5 refer to the latter.

Further spectra are being taken on a sample prepared according to the following procedure:—

Isolation of Dvi-Manganese.—Crude dvi-manganese compounds were extracted from pyrolusite as follows:—

The manganese dioxide (100 g.) was treated with a warm mixture of hydrochloric and sulphurous acids. The white insoluble residue was filtered off and rejected. Ammonium chloride (50 g.) was added to the filtrate, which was then made alkaline with ammonium hydroxide. Hydrogen sulphide was passed in until the solution was saturated with the gas. The precipitated sulphides were filtered off and the filtrate was re-treated repeatedly until no more sulphides separated.

The pale yellow filtrate was then evaporated to dryness, taken up with water, acidified with dilute acetic acid and just enough ammonium oxalate to precipitate all the calcium present.

The calcium oxalate precipitate, which was grey in colour, was filtered off and examined. It was found to contain from

61.6 to 62.2 per cent. of oxalate, $(COO)_2$. This suggests the presence of a metal of higher atomic weight than calcium.

The filtrate from the calcium oxalate was evaporated to dryness, and ignited, leaving a very light brown residue, readily soluble in hot dilute hydrochloric acid.

When this solution was concentrated, short feathery needles first formed.

The hydrate of Dvi-manganese was precipitated from this solution by means of ammonium hydroxide. This gave a white flocculent precipitate which gradually darkened. The warm filtrate slowly deposited more of the brown precipitate.

This was all filtered off and the filtrate kept for further examination.

Properties of the Oxide. The precipitate of "dvi-manganese hydroxide" was soluble in hot dilute hydrochloric acid, but was much more easily dissolved by sulphurous acid.

Caustic alkalis in solution did not dissolve it. It also remained undissolved when sodium peroxide was added, although it turned a dark chocolate colour. When treated with sodium hypochlorite, solutions of dvi-manganese salts again gave a light hydroxide precipitate which rapidly darkened.

When fused with caustic alkalis or sodium peroxide it gave a bluish-green product somewhat resembling the colour of nickel compounds.

This was readily soluble in water, giving a deep green solution, which possessed oxidising properties. Thus it was decolorised by solutions of ferrous sulphate, oxalic acid, sulphur dioxide, and by carbon dioxide. Any manganate present would have been converted to permanganate by carbon dioxide and this was not observed.

The solution of potassium dvi-manganate was, however, unstable, and in the course of a day had become almost colourless, having deposited the hydrated oxide of the element.

Reactions of Dvi-manganese Salts.

Like manganese dioxide, the dark brown oxide of dvi-manganese was readily soluble in a warm dilute hydrochloric acid and in sulphurous acid.

The solution gave purplish and grey-brown precipitates with potassium ferro- and ferri-cyanides, but no precipitate was obtained with sodium phosphate or ammonium oxalate.

The salt on a platinum wire coloured the bunsen flame bright green, but the colour persisted for a second only, although it could always be seen when care was taken to observe it. This fugitive colour may be accounted for by the volatility of the chloride.

An equivalent weight determination has been made using the crude oxide. This gave a rather low result, assuming dvi-manganese to have an atomic weight about 188.

The ignited higher oxide, after heating in a stream of oxygen was reduced to the lower oxide by heating in hydrogen.

0.2763 g. higher oxide gave
0.2361 g. lower oxide.

Assuming the atomic weight of dvi-manganese to be 188, this corresponds with a reduction from DO_4 to DO.

Part III. Foreshadowing Elements 75, 85, 87 and 93.

(By F. H. L.)

Reference in the introduction has been made to our prior work, so it will only be necessary here to deal critically with the data thus far obtained by means of the X-rays.

Referring to Table II., this is inherently explanatory with the exception of one or two features. The values given in Column 8 are those in Siegbahn's book with the exception of those calculated for elements 75, 85, 87, 93, and the blank spaces where the radio-atoms fall. In Column 4 it will be seen that the differences are graded so as to fit into the gaps. Keeping to the difference value, 0.879, throughout a considerable range led to writing the values in Column 3 for thorium low and bismuth high, the Siegbahn values being respectively 30.016 and 28.259. This slight irregularity for the sake of uniformity does not appreciably affect the newly-calculated values.

In order to arrive at the $L\beta_1$ values in Column 8, a curve was drawn as shown by Fig. 2, which is also self-explanatory. The broken line shows an alternative curve, the choice between the two being arbitrary.

Beginning at element of atomic number 75, the $L\alpha_1$ calculated wave-length agrees closely with one given by Berg and Tacke (see previous citation, Part I.), *viz.*,

1	2	3	4	5	6	7	8	9		10		11		12		13	
ELEMENT	AT. NO.	√ν/R †	DIFF.	λ Å.U. Lα₁ ‡	λ Å.U. Lα₂	MEAN α₁ α₂	λ Å.U. Lβ₁	FILM NO. 1.		FILM NO. 2.		FILM NO. 3.		FILM NO. 4.		FILM NO. 5.	
(* ———)	93	32·053	·380	0·8877	0·8995	0·8936	0·697							0·895	0·693	0·900	—
URANIUM	92	31·673	·379	0·90833	0·92014												
	91	31·294	·379														
THORIUM	90	30·915	·379	0·95342	0·96524												
	89	30·536	·379														
	88	30·157	·379											•			
EKA-CÆSIUM	87	29·778	·379	1·0276	1·0394	1·0335	0·837					1·032	—	1·040	—	1·040**	—
	86	29·399	·379														
EKA-IODINE	85	29·020	·379	1·0820	1·0938	1·0879	0·891							1·086	0·895	—	0·900
	84	28·641	·379														
BISMUTH	83	28·262	·378	1·14115	1·1533												
LEAD	82	27·884	·381	1·17202	1·18352												
THALLIUM	81	27·503	·378	1·20471	1·21603												
MERCURY	80	27·125	·376	1·2385	1·2497												
GOLD	79	26·749	·375	1·27355	1·28489												
PLATINUM	78	26·374	·377	1·31008	1·32121												
IRIDIUM	77	25·997	·376	1·34854	1·35939												
OSMIUM	76	25·621	·375	1·38816	1·3982												
DVI-MANGANESE §	75	25·246	·377	1·4298	1·4408	1·4353	1·2358	1·43	—	1·43	1·233	1·434	1·232			1·428	—
TUNGSTEN	74	24·869	·370	1·47348	1·48452												
TANTALUM	73	24·499	·374	1·51825	1·5294												
HAFNIUM ‖	72	24·125	·374	1·56607	1·57704												
LUTECIUM ¶	71	23·751		1·61551	1·62636												

* THE HIGHEST MEMBER OF THE MANGANESE GROUP.	OTHER LINES	OTHER LINES	OTHER LINES	OTHER LINES	OTHER LINES
† ν = FREQUENCY α₁ LINES. RYDBERG'S CONSTANT = 109737 = R.	Mn Kα & β	Cu Kα & β	Cu Kα & β	Cu Kβ	Cu Kα 1·537
‡ $10^8/[(\sqrt{\nu/R})^2 \times R]$ = WAVE-LENGTH, λ, IN Å UNITS.	Fe Kα & β		Br–Ag Abs.	λ = 1·045	Cu Kβ 1·389
§ OR RHENIUM.	Cu Kα & β			λ = 0·912	λ = 0·950
‖ OR CELTIUM (Ct).				λ = 0·763	λ = 0·916 Br Ab.
¶ OR CASSIOPEIUM (Cp).					λ = 0·735
** WIDE STRONG LINE. Br Kα₂ = 1·04172. Br Kα₁ = 1·03768.					λ = 0·651
←———————→ = SAME VALUE ENTERED TWICE.					

Table II.

NOTE.—Referring to Table II., the $L\alpha_1$ and $L\alpha_2$ lines are assigned intensities of 10 and 8 respectively in Günther's *Tables* (1924). Some regard the appearance of the weaker line improbable when the lines are obscured by the effect on the film of diffuse radiation, or absorption, or for other reasons. On one film the Kα and Kβ lines of copper were "obscured" for some reason (possibly variation in exposure) and appeared *equally weak*.

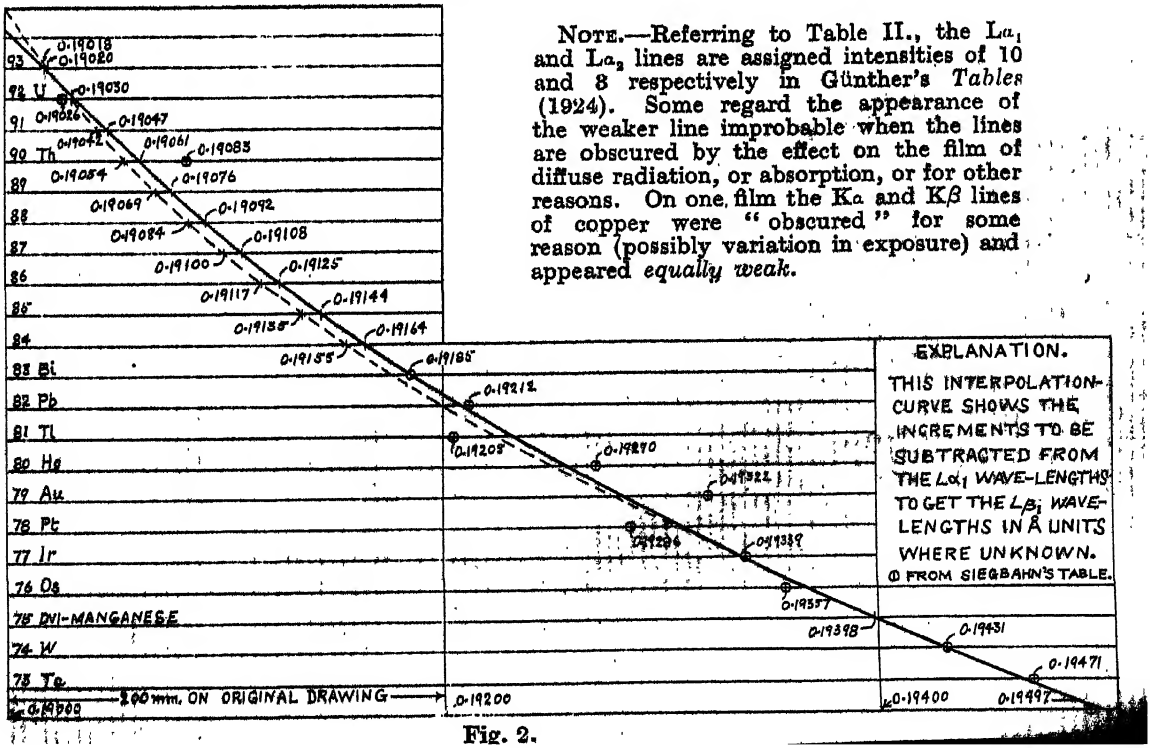

Fig. 2.

1.4299. This is within the error of our experiments in agreement with the $K\alpha$ line of zinc, viz., 1.434, but no $K\beta_1$ line of zine appeared on any of our films when dealing with the sample from manganese sulphate. One line cannot, of course, be excited without the other, but if of low intensity it would not appear under the conditions prevailing. Our average value comes out at 1.430. In one sample, made from pyrolusite, we got sufficient zinc present to produce strong $K\alpha$ and $K\beta$ lines. Messrs. Hilger checked the corresponding L lines from element 75, along with those from copper against the zinc lines, and reported in favour of line λ1.430 being that of element 75. To make sure that the copper anti-cathode was not emitting any other lines than those characteristic of copper, considering our long exposures, a 6-hour run was made with nothing on the face of the anti-cathode. This is important, because we feared that the $L\alpha_1$ line of mercury might account for the $L\beta_1$ line we obtained as from the element 75 which averaged 1.2325, the $HgL\alpha_1$ line being 1.2385. Our calculated value for the $75L\beta_1$ line was 1.2358 as against the calculated value given by Berg and Tacke, *viz.*, 1.2352.

We have not ignored the possibility of a mercury $L\alpha_1$ line appearing, for the powdered material on the anti cathode does not always adhere sufficiently close to the copper surface as to insure being kept down in temperature, though the anti-cathode is water-cooled. It will be remembered Aston (*Phil. Mag.*, May, 1923), found that mercury was completely eliminated from the discharge by the presence of cadmium, and it did not reappear "so long as the cadmium mirror [formed] remained on the walls of the discharge tube." Similarly, S. Smith (*Proc. Nat. Acad. of Sciences*, U.S.A., 1924, X., 4), found that "both lead and aluminium formed bright mirrors in the nereby portions of the tube [used for exploding electrically wires], while tungsten produced a band of dark stain on the glass. When the pre-explosion vacuum was good, none of the wires produced sufficient gas to pass a discharge. This is especially interesting in the case of aluminium, as this metal is ordinarily thought to contain much occluded gas. Possibly the gas is given off and then immediately reabsorbed by the thin film of aluminium on the walls of the tube." The absorption of gas, in our case mercury vapour, in and by the presence of certain metals that partially vapourise on the anti-cathode, might afford a means of getting the $L\alpha_1$ line of mercury, as mercury is employed to exhaust the tube used, but as the L spectrum would then be excited, we should expect the β_1 line to show as it has a strength of 8. No such line apeared when those of 75 were present. Messrs. Hilger regarded the α and β lines clearly registered on several films as those of element 75, as the foregoing reasoning indicates.

Considering now element 85, the evidence in this case is fairly good, but the lines were not as well-defined as one would wish.

As regards element 87, there is an appreciable difference between our calculated $L\alpha_1$ line, 1.0276, and the observed line, 1.032 (faint, but clear, and the only one on the film except those of 75 and copper), the difference being 0.0044, which is about our experimental error. Of course, the calculation of the $L\alpha_1$ line may be a little low, as it occurs in the middle of the blank region. We have connected the observed line with the mean between the $L\alpha_1$ and $L\alpha_2$ lines as the line showed quite a perceptible width, but it is to be expected that the former will have a strength of 10 as against 8 for the latter, so that, in measuring, the middle of the $L\alpha_1$ line would be taken. As explained before, the Br Ag absorption region seemed to block out the $L\beta_1$ line if present, moreover, its strength would be slightly less than the $L\alpha_1$ line.

The last element of all, of atomic number 93, was discussed in our first communication (Part I., this Journal, October 30, 1925), the possibility of this element existing having stimulated our research from the start. There is some evidence of its existence, but to be critical, the line 0.698 comes near to the limit of the region explored by the setting (oscillation) of the rocksalt crystal of the spectograph, and edge effects are possible here. At any rate, this may acount for some of the extreme "lines" given at the foot of Columns 12 and 13. However this may be, the values recorded as lines by Messrs. Hilger are very close to those calculated, that is to say, they are within our experimental error.

Films 1 to 8 are taken with the radiations of the first sample, which was made from manganese sulphate as described in

Part I. Films 4 and 5 are from a later sample made from pyrolusite.

Since the foregoing was written, we have a film from the sample made from pyrolusite, above referred to, which gives distinctly but faintly the lines 0.888 and 0.897 as measured by Messrs. Hilger. One line seems to correspond with the $L\alpha_1$ line of element of atomic number 93. Further X-ray spectroscopic work is in progress.

All values are, where the context admits, wave-length in Angström units, as before.

STERILISATION OF TOWN'S WATER.

THE USE OF CHLORINE GAS.

(FROM A CORRESPONDENT.)

At the 14th Annual Conference of the British Waterworks Association, held at the Guildhall, London, on the 1 July last, a particularly interesting paper was read by Sir Alexander Houston, the Director of Water Examination, Metropolitan Water Board, on the subject of the purification of London's water supply. This dealt with many different aspects of the complicated question of supplying over 7,000,000 people with household water, but one of the most interesting was that of sterilisation by means of a measured trace of chlorine gas, which reduces very considerably the reservoir accommodation necessary since the natural slow process of sterilisation by means of storage is thereby eliminated to some extent. Thus, for example, we learn from a previous report of the Metropolitan Water Board, about 76,000,000 gallons of London water is treated daily with chlorine, which, at the consumption of 38 gallons per head, corresponds to the requirements of 2,000,000 people, that is nearly one-third of the population of Greater London. The results have been highly satisfactory, although the magnitude of the problem of London's water supply is well illustrated by the new reservoir at Littleton, near Staines, which is one of the largest in the world. The capacity of 6,750,000,000 gallons is enough for a month's supply, the surface of the reservoir being 725 acres, the distance round about 4½ miles, and the cost £2,050,000, the total reservoir accommodation of London being now about 14,000 million gallons, although it would have to be considered greater if it was not for the chlorine treatment.

There is no question that the best way to use chlorine is in the form of pure liquified chlorine gas, about 1 part per 4,000,000 parts being the usual dose, although this varies somewhat depending on the iron and the dissolved organic matter content, which also absorb chlorine. The use of the gas instead of hypochlorites was first suggested in 1903 by Lieutenant Nessfield, of the Indian Medical Service, and applied in 1910 by Major Dornell, M.D., of the United States Army Medical Corps, and it has the great advantage of eliminating the inherent objection to the use of bleaching powder or sodium hpyochlorite, that of unstability, especially in warm weather. As is, of course, well known to chemists, the percentage of active chlorine, instead of always remaining at about, say, 35% for solid bleaching powder, and 14-16% with sodium hypochlorite solution, is apt to diminish to a considerable extent, render-it almost impossible for the attendant to control the exact amount of chlorine being supplied to the water. It is for this reason that chlorinated water sometimes tastes and smells slightly, since in order to make certain of complete sterilisation, excess of the reduced hypochlorite is added. The use of pure liquefied chlorine gas in cylinders, however, gets over this difficulty, since it is always pure 100% chlorine, and remains unchanged under all climatic conditions, whilst also it has the further advantages of not adding any soluble salts to the water.

Chlorine gas is used by means of the "Chloronome" apparatus of the Paterson Engineering Company, Ltd., of London; and other important points are easy adjustment and continuous automatic addition of the chlorine in the most accurate character, so that there is not the slightest taste or smell in the treated water, the cylinders of chlorine being conected to the "Chloronome" apparatus which by means of suitable reducing, regulating, and control valves, passes continuously a small stream of the gas, instantly adjustable in amount by one stop valve. This gas is absorbed by a trickle of water in a small absorbing tower forming part of the apparatus, and the dilute solution of chlorine passes into the main water supply, mixing almost instantly, a very important feature in practice, since it ensures absolute equal chlorination of the whole bulk of the water, otherwise not easy to obtain.

THE VITAMIN CONTENT OF CORTEX LIMONIS B.P.

Anent the abstract of the work of Dr. Juritz on the Citrus family, published in the *Chemical News* on November 13, we have been favoured by the authors, Stanley G. Willimott, Ph.D., B.Sc., A.I.C., and Frank Wokes, B.Sc., A.I.C. (pharmaceutical chemist), with a copy of an interesting paper under the above title, read before the Science Section at the British Pharmaceutical Conference at Glasgow, on July 30, 1925, and reprinted from the *Pharmaceutical Journal and Pharmacist* of August 1, 1926. The paper deals fully with most phases of the subject, and will constitute a valuable addition as a work of reference on an important subject.

We give attached two excerpts, one dealing with the historical aspect, and the other with the principal constituents.

Although lemons have been known from very early times, their use in medicine has arisen only quite recently. It seems probable that the genus Citrus originally came from Eastern Asia, and a number of species are now found inhabitating the warmer valleys of the Himalayas. Strasburger (4th English edition, 1912, p. 604) states that all the important cultivated forms have been obtained from the Chinese. *Citrus medica* is the form which was known to the Greeks in the expeditions of Alexander the Great as the Median apple. Lemons were only known to the Romans at a late period in their history, and were at first used only to keep the moths from their garments. Pliny mentions their effectiveness as an antidote to poisons. The great obstacle to the wide use of lemons was the difficulty of preserving them for any length of time; also their juice was disagreeably acid and would not keep, and this was not overcome until sugar became available in large quantities in the seventeenth century. A syrup of lemon juice was then made in Italy, and first imported into England somewhere about 1630. Meanwhile, the value of lemon juice in preventing scurvy, a disease dreaded by all who had to take long voyages in sailing vessels, was gradually becoming recognised. Lind ("A Treatise on the Scurvy," London, 2nd edition, 1757) recounts the tragic history of four ships which sailed from England to Bombay in April, 1600, carrying 480 men to establish the East India Company. The Commodore on his own ship had arranged for a regular issue of lemon juice, three tablespoonfuls daily to all hands, and at the end of the voyage his men were all in good health. On the other three ships, where no lemon juice had been issued, 105 men had died of scurvy, and the remainder were so weak that they could not unload their cargoes. Captain Cook, in his famous voyages in the following century, gave excellent examples of the prevention of scurvy by means of lemon juice, and it was probably this that led to its being made a regular issue in the Navy in 1804, after which scurvy, which had been responsible for thousands of cases annually, became comparatively rare. The value of the lemon juice was thought to be due to its acidity, and when it was later found that the juice of the West Indian lime (*Citrus medica* v. *acida*) was more acid than that of the lemon (*Citrus medica* v. *Limonum*), lime juice was gradually substituted. Thus lime juice has ursurped the reputation of lemon juice as an antiscorbutic, although as a matter of fact lemon juice is more than twice as effective (see table drawn up by staff of Lister Institute and published in the Medical Research Committee's Report on th present state of knowledge concerning accessory food factors, p. 41).

Although the *juice* was thus the first part of the lemon to be used medicinally, the virtues of the *peel* were not altogether ignored. Thus, in Dr. Nicholas Lemery's "Course of Chymistry," 3rd edition, London, 1698, p. 506, are given directions for the preparation of a Magistral or Compounded balm-water.

Principal Chemical Constituents.

In the oil are found the terpenes *d*-limonene α-terpinese, and α-phellandrene, the first being in largest amount, and the three totalling about 90 per cent. of the bulk of the oil; the aldehydes citral (minimum 4 per cent.) and citronellal; and the ester geranyl acetate, while linalyl acetate is said to occur in Palermo oil. The mucilage accompanying the oil requires further investigation.

Another important constituent is the glucoside hesperidin. This substance when hydrolysed yields hesperetin, rhamnose, and two molecules of glucose. It thus affords the plant a possible means of storing up the reserve energy represented by its reducing sugars, which, as has been shown above, it actually does in the un-

ripe fruit. Rhamnose being a methylpentose, is worthy of note for two reasons; first, because it offers resistance to the enzymes which act as the agents of decay, so that peculiar interest must be attached to the formation of hesperidin in large amounts in fruits which are commencing to decompose; secondly, because, being a pentose, it may possibly play a part in the synthesis of terpenes. (See Stewart's "Recent Advances in Organic Chemistry," pp. 259 and 270.) Citral being an open chain compound containing ten carbon atoms is perhaps another stage in this synthesis. It might perhaps be mentioned that citral occurs in very large amounts (up to 85 per cent.) in the oil obtained by distillation from lemon grass, *Cymbopogon citratus*, Staph (N.O. Gramineæ), a plant which has a very long-standing reputation as a cure for scurvy.

Trade and General Notes.

HOLLINGER (CANADA) GOLD PRODUCTION $95,000,000.

Official figures show that the Hollinger Consolidated gold mines had produced an aggregate of approximately $95,000,000 up to the end of September. Added to this are ore reserves which closely approach $60,000,000 thereby showing an aggregate of $155,000,000 so far disclosed in this comparatively new mine. This output, as well as the estimate of ore reserves, deals largely with what has been found above a depth of 1,450 feet.

BRITISH COAL MINING IN SEPTEMBER QUARTER.

Fresh low records of production, export and consumption are registered for the third quarter of the current year. The quantity of saleable coal raised was only 56 2/5 million tons, or 1 2/3 million tons less than in June quarter and 7½ million tons less than in the corresponding period reacher only 16½ million tons, or less than in any quarter since the end of 1921.

PRODUCTIVE CAPACITY IN GERMANY

In his report on the economic condition of Germany, Mr. J. W. F. Thelwall, British Commercial Secretary at Berlin, discusses the productive capacity of the country since the currency was stabilised and its power of competing with Great Britain. He states that the productive capacity within the present frontiers has certainly increased, the total taxation is probably less than in Britain, and the labour costs are lower. The German workman works longer and harder for less pay than does his British rival. German competition would be more severe than it is but for the financial difficulties under which German trade is labouring.

EXPLOSIVES IN MINES.

A Report* by the Explosives in Mines Research Committee on "Electrical exploders for shot-firing in coal mines," has just been published by the Safety in Mines Research Board.

The use in coal mines of permitted explosives, which are of the type of high explosives, requires the employment of a detonator, which, according to present practice, is fired by a magneto exploder. For safety and efficiency the magneto exploder must be incapable of igniting firedamp, but must be fully capable of igniting the detonator. The problems discussed in the present Report are those of devising safe and reliable exploders which will fulfil these conditions, or alternative means of providing the current necessary to actuate detonators.

* Safety in Mines Research Board Paper No. 11. H.M. Stationery Office, Adastral House, Kingsway, London. Price 1s. net.

WESTERN CANADIAN GRAIN CROP.

According to the Natural Resources Intelligence Service at Ottawa, the wheat crop for 1925 in Western Canada is estimated at 400,885,000 bushels. This figure is based on an estimated average of 20.1 bushels to the acre on 19,865,000 acres.

By provinces the production is estimated as follows: Manitoba, 88,684,000 bushels; Saskatchewan, 226,518,000 bushels; Alberta, 185,288,000 bushels. The aggregate estimate for oats is 892,658,000 bushels; barley, 65,855,000 bushels; rye, 9,220,000 bushels; and flax, 6,895,000 bushels.

BRITISH INDUSTRIES FAIR, 1926.

Canadian and East African Participation.

It is officially announced by the Department of Overseas Trade that both Canada and the East African Colonies have decided to take part in the British Industries Fair, which is to be held in London and Birmingham in February next.

NETHERLANDS.

TENDERS INVITED.

The Commercial Secretary at the Hague (Mr. R. V. Laming, O.B.E.), informs the Department of Overseas Trade that the Director of Government Medical Suppl es is inviting tenders, on behalf of the Department of War, for the supply of medicinal preparations for the year 1926.

The contract involves a wide range of supplies including acetone, acetic, boric, sulphuric and other acids, liquid ammonia, Peruvian balsam, glycerine, gum arabic, seed oils, etc., and also soft soap, calico, lint, wadding, wood wool, packings, and chamois leather.

Tenders should be made through local agents and should reach the Director of the Government Medical Supply Stores, Amsterdam, by the 1 December.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

November 5, 1925.

Among the papers read were the following :-

Lactic Acid in Mammalian Cardiac Muscle. Part II. The Rigor Mortis Maximum and the Normal Glycogen Content, by H. J. G. Hines, L. N. Katz and C. N. H. Long. Communicated by Professor A. V. Hill, F.R.S.

1. The rigor mortis maximum, or the caffeine rigor maximum, of lactic acid in the heart is only half that in the skeletal muscle.

2. A lack of lactic-acid precursor is not the cause of the relatively low stimulation maximum of lactic acid in the heart.

3. The glycogen content of the heart is much smaller than that of syeletal muscle in well-fed cats.

4. There is in the heart a greater discrepancy between resting glycogen content and the lactic acid produced in rigor mortis, than there is in skeletal muscle. It indicates that a greater portion of the lactic-acid precursor of the heart is in some other form than glycogen. It is possible that this may be hexose phosphate or some related compound.

Lactic Acid in Mammalian Cardiac Muscle. Part III. Changes in Hydrogen Ion Concentration, by Phyllis Kerridge, L. N. Katz and C. N. H. Long. Communicated by Professor A. V. Hill, F.R.S.

1. The pH's of cardiac and of skeletal muscles stimulated to fatigue are different; the difference is of the order of $0.2p$H, the skeletal muscle being the more acid.

2. The pH's of cardiac and of skeletal muscles in rigor mortis are different, the difference being of the order of $0.4p$H, the skeletal muscle being the more acid.

3. Cardiac and skeletal muscle have different buffering powers. The relative buffering powers vary at different pH's. The maximum difference is at pH of approximately 6.8, when the ratio of the buffering power of skeletal to that of cardiac muscle is about 2 : 1.

The Mechanism of Muscular Contraction, by W. E. Garner. Communicated by Professor A. V. Hill, F.R.S.

A mechanism of muscular contraction is proposed in which it is suggested that the tension generated on applying a stimulus to a muscle fibre is due to the formation of a solid film on the surfaces of the ultimate fibrils of the muscle.

The evidence bearing on the occurrence of molecular orientation in muscle fibre is collected together, and it is concluded that liquid crystals composed of long-chain carbon compounds are present in the anistropic segments of the muscle. The molecules of the long chain carbon compounds are orientated with their chains in a direction parallel to the axis of the fibre.

The manner in which a solid film might be produced on the surface of the anistropic segments of the muscle. The molecules of the long chain carbon compounds are orientated with their chains in a direction parallel to the axis of the fibre.

The manner in which a solid film might be produced on the surface of the anistropic segments by the action of lactic acid and the conditions under which a tension could be developed are discussed.

It is suggested that glycogen is converted into sodium lactate according to the series of reversible reactions $A \rightleftarrows B \rightleftarrows$ lactic acid, where A is a product formed from glycogen and B is an intermediate active form of both A and lactic acid. The direction of the chemical reaction may be influenced by alteration of the surface energy of the membranes during movements of the muscle. When the energy liberated during the conversion of glycogen into lactic acid is not utilised in doing external work, it may be stored, in part, by a reversal of the above reactions.

A simple model of an anisotropic segment of a muscle fibril is given, in which these conclusions are embodied. It is shown that the assumption of the production of a solid form, on the anistropic segments, by the action of lactic acid, is in accord with the experimental results on the force excited and the total energy liberated by a muscle when stimulated under various mechanical conditions.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society held at the Imperial College of Science and Technology on Thursday, 12 November, the following papers were presented and discussed:

Some Recent Improvements in Modern A.R.C.S., B.Sc.

The paper discusses the limitations inherent in the usual forms of fused bifocal lenses and the methods now being adopted for overcoming these limitations. A fused bifocal lens with a large power added for reading has a considerable amount of chromatic aberation, which is produced by the crown and flint glasses generally available for fusing having to be combined in a maner opposed to that required to produce a positive achromatic lens. In the newer bifocals the glass used for the major lens is of low refractive index and low dispersion; that used for the reading segment has a high refractive index and abnormally low dispersion, the relative dispersion being approximately the same as that of the major lens. The fused lens has thus no more colour in the reading portion than has an ordinary single lens of the power of the reading portion made from either glass. In the fused bifocals as usually made there is very limited control of the centreing of the reading portion. By using suitably shaped reading portions, the shape being determined partly by the power of the major lens, this difficulty has been largely overcome. The position of the reading section can also be fixed in such a position that the optical centres of both portions coincide, which is desirable in certain circumstances. For medium and high power lenses, a reduction in weight and a improvement in appearance, together with an increase in the field of view, have been obtaind by the fusion of suitable glasses.

Relation of Visual Acuity and Accommodation to Ametropia, by W. SWAINE, B.Sc.

The author has previously published a theoretical table showing how degrees of ametropia affect visual badness (*i.e.*, inverse of acuity). This paper is concerned with the comparison of artificially produced results on his own eye with the theoretical table.

An attempt is made at the same time to isolate the portion of the astigmatic pencil used in letter vision in astigmatic defects, with and against the rule, by using apparent accomodative esophoria as indicator.

Published work by the author in the same connection, and hitherto not indexed is also collected.

Irregular Astigmatism of the Eye Effect of Correcting Lenses, by H. H. EMSLEY, B.Sc.

Experiments to test the grating acuity of the eye in different meridians reveal the presence of irregular acuity, or irregular astigmatism as it is called. Comparisons are made between the ordinary subjective findings and tests made on gratings. The effects of changes of lens power on the acuity in different meridians are considered and a redistribution of the acuity over the several meridians during accommodation is indicated.

Some Causes of Apparent Astigmatism of the Eye, other than Cylindrical Errors of Refraction, by E. P. FINCHAM.

Visual acuity appears to be governed by the following factors:—

1. The quality of the optical image upon the retina.
2. The size and pattern of the grain of the retina, i.e., size, separation and arrangement of the retinal cones at the fovea.
3. The perception of the stimuli of the visual centres of the brain.

Measurements of visual acuity of a hypermetropic eye were made with a grating test. The results shewed that although the eye was able to make the necessary adjustment of the accommodation to correct the hypermetropic error for any in different meridians. The well-known phenomenon of "Glimpsing" effect is due to the third factor which has been mentioned. Other variations of acuity in different meridians could be explained upon the assumption of the presence of "Veins" of unegual refractive index in the media, or the striated character of the crystalline lens. Owing to the hexaxonal packing of the foveal cones, the separation of their outer extremities (presumably the sense organs) is different in different meridians. The separation is least in the three meridians in which lie the centres of adjacent hexagons. It is suggested that this fact will account for a variation in the "grating acuity" for different meridians.

"The Zeiss Refractionometer" was exhibited by Messrs. J. W. Atha and Co.

The Ophthalmic Parallax Refractionometer enables the optician to ascertain, without the active assistance of the patient, the vertex refraction of the distance spectacle lens required for the correction of an ametropic eye. By the application of the parallax principle and using a suitable magnification, an accuracy of 1/8 D can be obtained within a range of from 12 to +20 D, whilst the accommodation of the patients eye is eliminated. The position of the principal meridians of astigmatic eyes is easily found by its means.

THE INSTITUTE OF PHYSICS.

Public Lectures on Physics in Industry.

"The Physicist in Agriculture, with Special Reference to Soil Problems." (Illustrated). By Bernard A. Keen, D.Sc., F.Inst.P., Assistant Director and Head of Soil Physics Department, Rothamsted Experimental Station.

The above lecture will be given on Wednesday, November 25, 1925, at 5.30 p.m., in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1.

The chair will be taken by Sir Daniel Hall, K.C.B., F.R.S., Chief Scientific Adviser to the Board of Agriculture and Fisheries.

Synopsis.

Historical.– The importance of physics in the early scientific work on agriculture; neglect of the subject during the advances of chemistry and biology; the revival in recent years.

Modern Work. Recognition of the colloidal properties of soil shrinkage, swelling, heat evolution; some fundamental physical properties particle size, cohesion, plasticity; relations between soil and its water content vapour pressure, water retaining capacity; mechanism of water movement in soil evaporation, percolation, capillarity; the physical chemistry of soil water; factors controlling temperature and aeration; the border line between meteorology and soil physics; the scientific study of soil cultivation processes and implements.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE MINERAL ELEMENTS IN ANIMAL NUTRITION.

Section M. Agriculture.

Address by J. B. Orr, D.Sc.,

(President of the Section).

Though these results of disordered mineral metabolism can be produced under experimental conditions, it does not necessarily follow that they occur to any considerable extent under practical conditions. There is, however, strong circumstantial evidence that deficiency of one or more mineral elements is a common cause of malnutrition in farm stock. Indeed, in some cases, it has been possible to identify the deficiency; in these cases marked beneficial results follow the addition to the ration of the elements present in insufficient amount. This evidence, which has been accumulating during the past few years, now warrants the attention of the practical expert.

It may be of interest to consider some reasons which can be adduced for believing that the danger of deficiencies of minerals in the food of farm animals has been increasing in recent years. During the past half-century the types of animals after which breeders have been striving are those whose young have a very rapid rate of growth, or whose females have a great capacity for producing the constructive materials required for growth. A remarkable degree of success has attended these efforts of the breeders. Some breeds of pigs will increase from 2 lb. to 2cwt. in six

months. There are dairy cows which can secrete in their milk as much as 10-12 lb. of solid matter per day. There are hens that lay 200 to 300 eggs in a year. Now, the faster the rate of growth, the greater must be both the absolute amount of mineral matter required in a given time and the proportion of mineral matter per unit of energy in the food. The following table shows that the percentage of mineral matter in the milk of different species and also the amounts relative to the energy values, are in proportion to the rates of growth.

TABLE I.

	No. of days in which weight of new-born animal is doubled	Milk of species contains Ash %	Ash per 1,000 calories
	Days	Grams	Grams
Man	180	.25	3.7
Cow	47	.72	10.7
Pig	14	1.08	10.9
Rabbit	6	2.50	15

Hence, in modern types of animals the mineral requirements have increased *pari passu* with increased capacity for growth, and the danger of malnutrition through an absolute deficiency of any of the mineral elements, or a lack of balance of these constituents of the food, is correspondingly increased. As a matter of fact it is found that malnutrition due to disordered mineral metabolism occurs most readily in those animals that are growing fastest. In experiments with both dogs and pigs, it has been found that symptoms of rickets tend to appear earliest in those that are growing most rapidly.

Concurrently with the evolution of these faster growing types, with their greater need for each of the essential mineral elements in their food, and for a more perfect balance of these elements, there has been an increasing use of concentrates to support rapid growth. These concentrates, which consist chiefly of commercial by-products of cereal grains and tropical seeds and nuts, are markedly deficient in some of those mineral elements which are required for growth, or for the production of growth material. The following table compares the mineral matter of some of these artificial feeding stuffs with that of milk and good mixed pasture, the only two foodstuffs of which the mineral content corresponds approximately with the requirements of herbivora .

	Protein Gms.	Ca Gms.	P. Gms.	Na. Gms.	K. Gms.	Cl. Gms.
Cultivated pasture	65.8	2.65	1.18	.69	9.58	3.52
Cow's milk	51.6	1.78	1.52	.58	2.66	1.89
Potatoes	21.4	.19	.65	.29	4.61	.32
Maize	28.6	.02	.76	.08	1.18	.0008
Wheat	35.0	.18	1.18	.11	1.82	.15

It is seen from the table that foodstuffs such as tubers and cereals, are deficient in calcium, chlorine, and sodium. Most concentrates resemble cereals in their mineral composition.

A third factor with an adverse effect on mineral metabolism is the increasing tendency to feed large numbers of animals together. This necessitates for practical purposes the adoption of fixed standard rations, which may be fed with little or no change for months on end, or even through the whole life cycle of the animal. Unless such rations are almost perfectly constituted with regard to mineral content, there must be a cumulative effect of any deficiency or lack of balance which would not occur in the case of either single animals or small groups, fed in a more haphazard fashion. As a matter of fact, in practice, the cottager's pig, with a varying diet consisting largely of scraps, differing in kind from day to day, seems liable to disease and more successful in bearing and rearing large litters than pigs fed in large numbers under what might almost be termed factory conditions.

The reasons adduced above seem valid enough to justify the fear that, under modern conditions of intensive production in animal husbandry, there is a danger of malnutrition and disease arising on account of defects in the inorganic portion of the ration. Acting on this belief, attempts have recently been made to increase the rate of growth and improve the condition of the animals by the addition of various mineral salts thought to be present in their

rations in insufficient amounts. In many cases, marked beneficial effects have been noted. Thus, in pig-feeding, the cereal grains and most other foodstuffs commonly used in making up rations are deficient in calcium, sodium, chlorine, and in some cases, iron and iodine, and it has been found that growth, health, and reproductive capacity all tend to be improved by the addition to the food of salt mixtures containing these elements. The high requirement of the rapidly growing pig for minerals is now so generally recognised that it need not be further discussed here. Most manufacturers of pig-meals now adjust the mineral content of their meals by the addition of the minerals thought to be deficient.

In poultry it has been found, in experiments carried out at Ohio and at stations in Scotland and Northern Ireland, that even though the birds have access to green food and lime or oyster shell, egg-production can be increased by the addition to the cereal rations usually fed to poultry, of a mixture of those salts which are present in the ration in smaller proportions than in egg. The increased egg-production is due to a lengthening of the laying period. Apparently the mineral additions prevent the cereal grains, by the addition of calcium and chlorine, which are deficient, increases the rate of growth and improves the quality of the fleece. A striking example of the importance of mineral salts in the diet of sheep comes from Michigan, where, owing to high mortality, the sheep industry suffered seriously. The feeding of mineral salts found in deposits near the Great Lakes was followed by the disappearance of the trouble.

Some interesting cases of deficiencies of one or more minerals in natural pastures have been discovered. In an investigation being carried on partly at the Rowett Institute, and partly at the Nutrition Institute at Cambridge, it has been found that there are marked differences in the mineral content of uncultivated pastures grown in different localities, and that there appears to be a correlation between the mineral content of the pasture and its feeding value, as determined by the number of stock it can carry, and the health and breeding capacity of the stock. An interesting fact brought out is that, where the sheep have a choice of pastures, they actually eat the herbage the mineral composition of which most closely approximates to that of good cultivated pasture. As we saw above, good pasture contains the various elements in proportions somewhat similar to those which are found in milk and might therefore be presumed to be suitable for growth and the maintenance of health, as indeed is found to be the case in practice.

In various countries where the modern type of rapidly-growing animal has been put to graze on uncultivated pastures, malnutrition, as shown by stunted growth, low milk yield, or increased liability to disease, depletion of the skeleton and other tissues which would otherwise terminate egg-production.

Of all farm animals, the stall-fed heavy milking cow is the one most likely to suffer from depletion of minerals from the tissues and consequent malnutrition, on account of the fact that she loses from her body such relatively large quantities of mineral matter in the milk. In short tests, running for a few days or weeks, the adjustment of the mineral matter of the ration is not usually followed by increased milk production, because the cow will continue to give milk even though the body is being depleted of minerals. But the influence of adjusting the ration is seen towards the end of a long lactation or in a subsequent lactation. In recent tests at Beltsville and Ohio and at Aberdeen, which have been carried over one or more complete lactation periods, it has been found that the adjustment of the ration by the addition of salts present in too small amounts has resulted in a rather greater yield of milk and in an increase in breeding capacity and decrease in disease. The number of such prolonged feeding experiments with dairy cows is, however, not sufficient to enable conclusions with regard to the value of the mineral additions to be drawn with the same degree of certainty as in the case of pigs or poultry.

In recent experiments with hand-fed sheep, it has been found that the adjustment of a ration of turnips, straw and has appeared. Thus, in South Africa, Sir Arnold Theiler and his associates have shown that deficiency of phosphorus in the pastures is the cause of pica (depraved appetite), which is prevalent in cattle in certain districts there and which leads to the ingestion of the organism which causes lamziekte, and the condition can be pre-

vented by feeding bone meal, or any food stuff rich in phosphorus. Not only does this adjustment of the mineral intake prevent the disease, but the general condition of the animals is improved.

(To be continued.)

BRITISH ASSOCIATION OF SCIENCE 1925 (SOUTHAMPTON) TRANSACTIONS.

[ABSTRACTS.]

MR. J. A. V. BUTLER. *The Seat of the Electromotive Force of the Galvanic Cell.*

The discovery of the production of an electric current by galvanic action gave rise to two distinct views of its origin, resulting in a controversy which was waged with considerable zeal for a century, without a decision being reached (cf. Sir Oliver Lodge's comprehensive report, *B.A. Report*, 1884). On the one hand, physical theorists regarded as the chief factor a contact P.D. between the metals, identified with Volta's contact force and an intrinsic property of the metals. On the other hand was the chemical view that the current had its origin in chemical effects at the electrodes.

In the course of the nineteenth century, the chemical theory received convincing support from (1) the work of Davy and Faraday, which established the quantitative relation between quantity of electricity and chemical action; (2) the discovery of the relation between the electrical energy produced and the energy of the reaction going on in the cell [Kelvin (1851) had postulated the equality of these. The exact thermo-dynamical relation was given later by Helmholtz and Gibbs]. (3) The Nernst conception of the process at metal electrodes which accounted for the effect of concentration. The chemical theory thus appeared to be established on all points. The Volta effect itself was explained as due to chemical action at the surface of the metals. For thirty years the metal junction was practically overlooked as an important contributor to the e.m.f. of the cell.

Recent work on the thermionic and photoelectric properties of the metals (Richardson, Compton and Millikan) has, however, conclusively demonstrated the existence of large metal contact P.D.'s. How are these to be reconciled with the chemical theory? The author's theory, based on statistical considerations, is outlined, which includes as different aspects of the whole truth (1) the existence of metal contactcontact P.D's between metals, approximately equal to the difference of their thermonic work functions; (2) the relation between e.m.f. and the energy of the chemical reaction expressed in the Gibbs-Helmholtz relation; (3) the Nernst relation for the effect of concentration.

PROF. E. C. C. BALY, F.R.S., MR. F. M. JOHNSON, MR. H. G. LITTLER, AND MISS EDITH MORRISON. *Further Investigations on the Photosynthesis of Naturally Occurring Compounds.*

The earlier results obtained by Baly, Heilbron, and Barker, on the conversion of carbonic acid into formaldehyde by the action of light, have been adversely criticised. It has now been found that the discrepancies are due to the existence of a photostationary state. In the original paper, the view was put forward that the synthesis of carbohydrates takes place in two stages, the first being the production of formaldehyde, which under suitable conditions polymerises into reducing sugars. This view is not correct, since under the action of light, the carbonic acid is converted into active formaldehyde which at once polymerises into carbohydrates.

In the complete absence of impurities, a photostationary state is set up which can be represented by the equation

$$6H_2CO_3 \quad C_6H_{12}O_6 \quad 6O_2$$

The removal of the oxygen causes the reaction to proceed from left to right. In the living plant the oxygen is removed from the sphere of action by the plant pigments. Investigation has also been made of the compounds formed by the polymerisation of the active formaldehyde, and it has been found that the first products are hexose sugars.

The phenomenon of the photostationary state seems also to exist in the photosynthesis of nitrogen compounds with activated formaldehyde, reactions in which again oxygen is evolved. This is of some importance, because the removal of the oxygen is necessary for the photosynthesis to proceed.

The very remarkable influence of the hydrogen ion concentration in the photosynthetic process has been demonstrated, and it apears that this is one of the most important factors.

(To be Continued.)

THE INSTITUTE OF PHYSICS.

The following have been elected to Corporate Membership:

Transferred from Associateship to Fellowship—C. Croxson, L. J. Sutton.

Fellow—A. C. Jolley.

Associates—B. B. Banerji, A. R. Greatbatch, M. Koenig, G. O. C. Probert.

NOTICES OF BOOKS.

Elementary Qualitative and Volumetric Analysis, by F. H. CAMPBELL, D.Sc., F.A.C.I. The University, Melbourne. Price 6s. 6d. net. McMillan and Co., Ltd., London.

This book, which extends to 100 pages, will be found very helpful to the young student, and is probably all the more valuable because of the exclusion of the formulæ for dangerous experiments that are risky in the hands of beginners. The author aims at inculcating on the part of the student a spirit of accurate observation and logical thinking, and the expected results will follow if the book is read with the necessary mental concentration. There is given a detailed alphabetical index, which will be found useful for ready reference.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.
CANTOR LECTURES.

The second Cantor Lecture on "Coal Ash and Clean Coal," will take place at the Society's Hall, John Street, Adelphi, London, at 8 p.m., on Monday, November 30, by R. Lessing, Ph.D., F.C.S., M.I.Chem. E. The third Lecture will take place on Monday, December 7, at 8 p.m.

ROYAL SOCIETY OF ARTS.
John Street, Adelphi.

December 2.—Lieut-Colonel. Sir Alan H. Burgoyne, M.P., A.M.Inst.A.E., "The Future of the Motor Car." Colonel Sir Thomas A. Polson, K.B.E., C.M.G., will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, W.C.

Wireless Section Meeting, Wednesday, 2 December, 1925, at 6 p.m. (Light refreshments at 5.30 p.m.) "The Performance of Amplifiers," by H. A. Thomas, M.Sc.

December 8. Professor S. P. Smith, D.Sc, "An All Electric House." (Dundee Centre (at University College), 7.30 p.m.

December 10. J. K. Murray, "Some Features of Telegraph Engineering."

December 1, T. Carter, "The Engineer: His Due and His Duty in Life." North-Western Centre, Engineers' Club, 17, Albert Street, Manchester, at 7 p.m.

December 2. Professor S. P. Smith, "An All-Electric House." Western Centre at Chamber of Commerce, Swansea, at 7 p.m.

SOCIETY OF PUBLIC ANALYSTS
AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, December 2nd, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m.

The following papers will be read:

"Measuring the Smoke Pollution of City Air, by J. S. Owens, M.D. (Meteorological Office, Air Ministry).

"2 : 4 Dinitrophenylhydrazine as a Reagent for Aldehydes and Ketones," by Oscar L. Brady, D.Sc., F.I.C., and Gladys V. Elsmie."

"The Determination of Phosphoric Acid as Magnesium Ammonium Phosphate," by Gunner Jörgensen.

"On the Effect of 'Blowing' on the Composition of Certain Fatty Oils," by C. H. Thomson.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

28,069. Bringhenti, P. Concentrations of solutions. November 7th.

27,770. Campbell, D. F. Electric reduction of zinc, etc. November „ 4th.

27,765. Grasselli Chemical Co. Electrolytic deposition of cadmium. November 4th.

27,760. Kyber, W. Manufacture of phosphoric Acid. November 4th.

Specifications Published.

219,971. Meyerhofer, A. F. Process of producing soluble carbonates or

hydroxides from insoluble carbonates, oxides, or hydroxides.

226,490. Meyerhofer, A. F. Process of producing salts of complex hydrofluoric acids.

220,649. Synthetic Ammonia & Nitrates, Ltd. Catalytic production of hydrogen.

241,669. Mills, L. D., and Crowe, T. B. - Recovering cyanogen from solutions.

Abstract Published.

239,758. Sodium pentaborate. Borax Consolidated, Ltd., 16, Eastcheap, and Kelly, A. A., 57, Chancery Lane, both in London.

Sodium pentaborate is obtained by treating a boron ore such as boronatrocalcite with sulphur dioxide until the bulk of the ore is saturated, then adding a calculated quantity of untreated ore and heating the whole in water preferably with the addition of a small quantity of sodium sulphate to increase the yield. If the quantity of sulphur dioxide absorbed by the ore is just sufficient to saturate the calcium contained in it, no addition of untreated ore is necessary.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

NAZOL.

B461,891. A medicated paste for human use in the treatment of catarrh and similar affections.- United Chemists' Association, Ltd., Ucal Works, Priory Court, London Rd., Cheltenham. November 4th, 1925.

POTENTINE.

462,796. Chemical substances prepared for use in medicine and pharmacy.— Crown Chemical Co., Ltd., 52, Crutched Friars, London, E.C.3. November 4th, 1925.

KOMO.

458,695.- -All goods in Class 2, which includes chemical substances.— Paton, Calvert and Co., Ltd., Binns Road, Old Swan, Liverpool. November 11th.

461,855. Device bearing Monogram of letters B.B. and the word BRITISH BYE-PRODUCTS, for chemical substances used for Agricultural, Horticultural, Veterinary and Sanitary purposes. Alan Johnston & Partner, Abbey House, Victoria Street, Westminster, London, S.W.1. November 11th.

THE CHEMICAL NEWS,

VOL. CXXXI. No. 3425.

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TELEPHONES:
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SILICOSIS AMONG MINERS.

By R. R. SAYERS.

(*Chief Surgeon, Bureau of Mines, U.S.A.*)

Dust in any mine may be a health hazard. In bituminous or sub-bituminous coal mines it may also be an explosion hazard, but the present discussion is limited to the effects on men of breathing certain dusts in mines. Some dusts may cause disease by their poisonous action as dust from lead, arsenic, or mercury ores. Other dusts, when breathed, irritate the lungs and cause a disease known by the general name of "pneumoconiosis." This lung disease is called "silicosis" when it is due to breathing rock dust (especially fine silica), "anthacosis" when due to breathing coal dust, and "siderosis" when due to breathing iron dust. Silicosis is also known as miners' phthisis or miners' consumption. Anthracosis is sometimes called coal miners' phthisis or coal miners' asthma. Breathing dust sometimes results in or predisposes to bronchitis and other respiratory diseases.

The disease is known to exist in a great part of the hard-rock mining districts of the world. It was studied in Western Australia by Dr. J. H. L. Cumpston, who reported in 1910 (4). He found that the death rate from respiratory diseases among all male non-miners over 15 years of age was 167 per 100,000, whereas the rate among miners was 589 per 100,000. The death rate due to tuberculosis among males over 15 years of age was 6, whereas among miners it was 192 per 100,000.

In 1921, among 6,538 miners at Broken Hill, New South Wales, 873 were found to have some incapacity due to effects of dust on the lungs (29).

In 1922, in New Zealand (28) 2,012 men were employed in gold mines, of whom 1,138 worked in quartz gold mines. During that same period 506 former gold miners received an annual compensation for incapacity due to effects of silica dust.

More work has been done in South Africa than in any other country on the study of silicosis, as a far greater number of men, from 12,000 to 15,000 whites and about 180,000 blacks, in a limited region are exposed to rock dust containing a high percentage of silica. For the years 1908-1909 the Miners' Phthisis Commission of South Africa (14) considered that out of a mining population of 12,000, approximately 1,000 men in any one year would reach the stage ofdefinite incapacitation.

On account of the heavy morbidity from miners' phthisis, a Miners' Phthisis Medical Bureau was established in Johannesburg in 1916 under Government auspices (28). By periodical examinations of the miners actually employed, 738 were found to be suffering from simple silicosis in the year 1916-17, 700 in the year 1917-18, 704 in the year 1918-19, 1,572 in 1919-20 (this year the antiprimary stage was included), 448 in the year 1920-21, and 431 in the year 1921-22.

SUMMARY.

1. Silicosis or miners' phthisis has been known to occur among miners in certain districts for centuries.
2. Silicosis is found among metal miners in New Zealand, Australia, South Africa, Great Britain, and in many of the States of the United States.
3. Silicosis is due to breathing very fine rock dust. Rock dust high in free silica is found to be most injurious.
4. Silica dust is somewhat soluble in water and in weakly alkaline liquids similar to body fluids.
5. Some physicians have thought that silica dust by its sharp-edged and needle-like particles injures the lung tissue mechanically. Another belief is that the silica, being soluble in water and weakly alkaline liquids, (5) injures lung tissue by its poisonous action.
6. The rate of development of silicosis depends upon the character of the dust, the amount breathed, length of exposure, past illness (especially tuberculosis), and physical fitness of the men.
7. Among gold miners in South Africa the average length of exposure to silica dust before silicosis develops is $7\frac{1}{2}$ years, the

shortest period of exposure for like results is $2\frac{1}{2}$ years.

8. Silicosis is usually divided into three stages: The first shows symptoms and caused by exposure to dust, but capacity for work is not impaired. The second stage shows definite signs of silicosis and capacity for work is impaired, although not seriously or permanently. The third stage shows that specific signs of silicosis are or have been present and the capacity for work has been seriously and permanently impaired by the disease.

9. The cardinal symptom of silicosis is shortness of breath, especially on exertion. The cardinal sign is diminished expansion of the chest. Both are slight in the early stages and increase gradually with development of the disease. Other symptoms and signs, as coughing, frequent colds, pains in the chest, and X-ray findings, are very important in making a diagnosis.

10. Men having silicosis are more susceptible to tuberculosis than normal men.

11. Men with silicosis can improve in suitable surroundings to recovery in the first stage, can improve materially in the second stage, and somewhat in the third stage.

12. Many methods for determining the amount of dust in the air are available. The sugar tube method, the konimeter, and the impinger are chiefly used in the mining industry in the United States.

13. The elimination of silicosis among miners depends on preventing the formation of dust by wet mining methods- wet drilling and wetting sides, roof and bottom, muck, and rock piles; the use of sprays and water blasts to lay the dust after blasting; good mechanical ventilation to replace dusty air with clean air; and physical examination of all miners before employment and periodically thereafter.

14. All of these means of prevention must be practised to insure success.

A NON-INTERMITTENT SENSITOMETER (TIME SCALE EXPOSURE MACHINE) WITH CLOCK-CONTROLLED MOTOR DRIVE.

By Raymond Davis.)
(*U.S.A. Bureau of Standards.*)

The work of the Bureau of Standards, in studying photographic materials and processes, has a threefold objective, namely, an inquiry regarding the nature and causes of photographic action and phenomena, the application of photography to scientific research, and the standardisation of the methods and procedure for testing photographic materials. The sensitometer described in this paper is a special instrument designed for both research and testing purposes, and has, therefore, a more extended range than is necessary for testing purposes. It is a sector-wheel machine in which the entire exposure takes place during one revolution. The sector wheel may be run at a wide range of speeds of from 480 to 0.0586 r.p.m. This speed range is covered in steps varying by powers of two, and is obtained by means of change gears that connect the sector wheel shaft with either of two other shafts which are driven through worms and gears by a constant speed motor at fixed, but different speeds. A new arrangement of the apertures in the sector wheel is used. The principal details of the construction and calibration of the sector wheels are given.

To drive the sensitometer a special circuit has been devised in which the shunt-wound motor is adapted to the centrifugal governor for maintaining constant speed. An additional refinement has been added whereby clock signals are applied to automatically and promptly compensate for small speed irregularities.

Summary.

This paper is a description of a non-intermittent exposure machine constructed for use in photographic research.

A short résumé is given of similar apparatus followed by a somewhat detailed description of the principal parts and their functions.

Several modifications of sector-wheel design are discussed and the procedure given for calibrating the angular apertures together with the precision attained.

A new circuit is made use of for adapting the shunt motor to the centrifugal governor for the purpose of driving the apparatus. Another feature is the method employed to correct incidental irregularities in the motor speed by synchronising its rate with clock signals.

THE STRUCTURE OF MANGANESE.

By Hawksworth Collins, B.A. (Camb.).

The constitution of an atom of manganese was shown to be SiAl in *the Chemical News*, 1920, CXX., 265; and its structure was there given in full. This definite result was obtained by reasoning upon the atomic weights and valences of several elements, making use of the Odd and Even Rule, the Inter-relationship of the Elements, the Periodic Observation, and facts of mineralogy.

The constitution, Mn SiAl, will now be proved to be correct quite independently by means of two absolutely independent series of experimental data, *viz.*, S.G., and H.F., neither of which came into the former proof.

TABLE I.

The Relative Volumes of Mn.

(1)	Mn(55)	Si(28)	Al(27)
(2)	6.94	3.2	3.74
(3)	7.13	7.13	0
(4)	13.02	13.02	0
(5)	11.53	11.53	0
(5A)	9.56		

All these volumes and part-volumes are demonstrated in Table II. The latter have all been employed in previous papers.

TABLE II.

Experimental Data Illustrating Table I.

	Relative Volume	Theor S.G. at 15° C.	Obs. S.G.	
(6)	Mn 6.94	7.925	8.013	John
			7.206	Brunner
(7)	MnSi 6.94 + 7.13	5.90	5.90	15° Nostrand
(8)	$MnSi_2$ 6.94 + 2(7.13)	5.24	5.24	13° Nostrand
(9)	Fe_3C 3(6.4) + 5.69	7.235	7.07	16° Nostrand
			7.396	International
(10)	FeB 6.4 + 2.9	7.20	7.15	18° Nostrand
(11)	MnB_2 6.94 + 2(2.9)	6.04	6.04	19° Nostrand
(12)	Fe Si, 6.4 2(3.2)			
(13)	SiC 7.13 + 5.69	3.12	3.12	15° Nostrand
(14)	FeSi 6.4 + 7.13	6.21	6.17	Pick and Conrad
(15)	$FeSi_2$ 6.4 + 2(7.13)	5.42	5.4	Pick and Conrad
(16)	Fe_2Si 2(6.4) + 7.13	7.03	7.0	Pick and Conrad
(17)	Fe_3Si_2 3(6.4) + 2(7.13)	6.7	6.7	Pick and Conrad
(18)	Co 6.78	8.702	8.71	Lampadius
			8.558	Henry
(19)	Co = AlS 6.78 = 3.74 + 3.04	(*C. N.* 1924, CXXIX, 107).		
(20)	$MnO.H_2O$ 7.13 + 2.51 + 18.02	3.22	3.258	15° Schulten
(21)	MnO_2 7.13 + 7.53 + 2.51	5.007	5.04	Dana
(22)	MnS_2 13.02 + 2(10.51)	3.496	3.463	Hauer
(23)	$MnCl_2$ 13.02 + 23.01 + 15.085	2.47	2.478	Schroder
(24)	$MnSiO_3$ 13.02 + 18.91 + 3(2.51)	3.32	3.350	Nostrand
(25)	$MnSO_4$ 13.02 + 15.53 + 2(7.53 + 2.51)	3.1	3.1	14° Bodeker
(26)	Mn_3O_4 13.02 + 2(11.53) + 2(4.45 + 2.51)	4.58	4.325	Playfair and J.
			4.053	Playfair and J.
(27)	$KMnO_4$ 18.05 + 13.02 + 3(7.53) + 4.45	2.72	2.71	Kopp
(28)	MnS 11.53 + 10.51	3.95	3.95	Leonhard
(29)	$MnCO_3$ 11.53 + 3 + 7.53 + 2(2.51)	3.585	3.592	Mohs
			3.558	Karsten
(30)	$MnSO_4.5H_2O$ 11.53 + 15.53 + 2(7.53) + 2(2.51) + 5(14.03)	2.055	2.059	16° Pape
(31)	$MnCl_2$ 11.53 + 2(15.085)	3.022	2.977	25°/4 Baxter
			i.e., 3.0	15°
(32)	$Mn_3P_2O_8.3H_2O$ 3(11.53) + 2(14.56) + 2(4.45) + 6(2.51) + 3(14.03)	3.15	3.102	Dana
(33)	MnO 11.53 + 2.51	5.06	5.091	Rammelsberg
(34)	$MnSiO_3$ 9.56 + 18.91 + 3(2.51)	3.64	3.68	Hermann
			3.65	Fino

TABLE III.

	Heat of Formation of Mn.	Original Volume	Rel. Vol. in combination	Change of Volume
(35)	$-9834 = 120 \times (1.49) \times 55$	11.53	13.02	1.49
(36)	$-1254 = 120 \times (0.19) \times 55$	6.94	7.13	0.19
(37)	$0 = 120 \times 0 \times 55$	11.53	11.53	0
(38)	$13020 = 120 \times 1.97 \times 55$	11.53	9.56	+ 1.97
(38A)	aq.260			

TABLE IV.

Experimental Data Illustrating Table III.

	Heat of Formation.	Theor.	Obs.	
(39)	$Mn.O.H_2O$ $-1254 + 96155 + 0$	94901	94770	T
	(corresponds with No. 20)			
(40)	$Mn.O_2$ $-1254 + 32341 + 96155$	127242	126000 125300	
	(corresponds with No. 21)			
(41)	$Mn.O_2.SO_2$ $-9834 + 2(96155)$ 6217	176259	178790	T
(42)	$Mn.S.O_4$ $-9834 + 0 + 2(32341 + 96155)$	247158	249400	
	(corresponds with No. 25)			
(43)	$Mn_3.O_4$ $-9834 + 2(0) + 2(71515$ $96155)$	325506	324900 328000	
	(corresponds with No. 26)			
(44)	$Mn.O_2.H_2O$ $-9834 + 96155 + 32341 + 0$	118662	116330	T
(45)	$K.Mn.O_4$ 36100 $-9834 + 3(32341) + 71515$	194804	194825	T
	(corresponds with No. 27)			
(46)	$Mn.C.O_3$ $0 - 13855 + 32341 + 2(96155)$	210796	210800	
	(corresponds with No. 29)			
(47)	$Mn.Cl_2$ $0 + 2(56786$	113572	111990	
	(corresponds with No. 31)			
(48)	$Mn_3.P_2.O_8$ $3(0) + 2(8593) + 2(71515) + 6(96155)$	737146	737500	
	(corresponds with No. 32)			
(49)	aq.$Mn.S.O_4$ $0 + 6217 + 2(32341 + 96155)$	263209	263200	
(50)	aq.$Mn.O.N_2O_5$ $0 + 32341 + 85332$	117673	117720	T
(51)	$Mn.O.CO_2$ $0 + 96155 + 32078$ 13855	114378	113880	T
(51A)	gas $C.O_2$ $-32078 + 32341 + 96155$	96418	96960	T
(52)	$Mn.O.SO_3$ $0 + 96155 + 96155 - 71515$	120795	121250	T
(52A)	aq.$S.O_3$ $6217 + 2(32341) + 71515)$	142414	142410	T
(53)	aq.$Mn.Br_2$ $260 + 2(52930)$	106120	106120	T
(54)	aq.$Mn.I_2$ $260 + 2(37720)$	75700	75700	T
(55)	aq.$Mn.Cl_2$ $260 + 2(63870)$	128000	128000	
(56)	$Mn.Si.O_3$ $13020 - 24797 + 3(96155)$	276688	276300	
	(corresponds with No. 34)			
(57)	aq.$H.Cl$ $-24350 + 63870$	39500	39315	T
(58)	liq. H_2O $-2(24350) + 117460$	68760	68360 69000	Thomsen Berthelot

(59) Mn.O.H_2.O 1254 + 96155
2(24350) + 117460 163661
(Obtained from Nos. 39 & 58)
(60) aq. Ba.O_2.H_2 72134 + 71515 +
117460 2(15300) 230509 220200
(61) Ba.S. O_4 81926 + 0 + 2(32344) +
96155) · 358918 339400
(62) aq. Ba.Cl_2 72134 + 2(63870) 199874 199210
(63) aq.Mn.F_2 260 + 2(77500) 155260 156800
(64) aq.H_2.S.O_4 2(24350) + 6217 +
2(32344 + 96155) 211509 210770 T
(65) aq.H_2.S.O_4.H'_2O 214509 3205 211304

Heat of Neutralisation.

When (59) and twice (57) produce (55) and twice (58),

96155 becomes 117460
1254 becomes 260

(66) 117460 96155 + 260 + 1254 22819 22050 T

Heat of Decomposition.

When (49) and (60) produce (59) and (61),

72134 becomes 81926
71515 becomes 96155
2(15300) becomes 2(24350)
6217 becomes 0
0 becomes 1254

(67) 81926 72134 + 96155 71515
2(24350) + 2(15300) 6217 1254 8861 10304 T

Heat of Solution of Metal.

When Mn is dissolved in (57) producing H_2 and (55),

2(24350 becomes 0
0 becomes 260

(68) 260 + 2(24350) 48960 49870 T

Heat of Neutralisation.

When (59) and (65) produce (49) and three times (58),

- 1254 becomes 0
96155 becomes 117460
3205 becomes 0

(69) 1254 + 117460 96155 + 3205 25764 26480 T

Heat of Decomposition.

When (40), (58, and twice (57) produce (55) and (65),

0 becomes 260
0 becomes - 3205

(70) 260 - 3205 - 2945 · 2528 T

The volume 7.13 is exactly correct for ten independent reasons. It satisfies the laws of relative volume and heat of formation, and occurs eight times in Table II. Similarly, 6.04 is correct for six, 13.02 for eight, and 11.53 for eleven independent reasons.

Summary.

The intricate and exact manner in which numerous and varied experimental facts have to fit in with one another for the demonstration of this proof of the structure of an atom of manganese makes it absolutely certain that the correct constitution has been obtained. A small portion only of this proof will now be considered, *viz.*, the molecule MnO_2 (No. 40), in order to make plain exactly what is implied by the frequent statement "corresponds with No. 'X'" in this and preceding papers. In order that this statement may be justified, it is necessary that the following mathematical operations should have been successfully performed upon experimental data :

(A)---Divide the molecular weight by the specific gravity at 15° C., in order to obtain the total relative volume, allowing 1% for experimental error. Result : - 17.17.

(B) Split up this volume into three parts, one for each atom concerned. This can only be done by a systematic study of all the thousands of substances of which the S.G. has been recorded. Result : 7.13 + 7.53 + 2.51.

(C) Find the original volume of Mn; i.e., its relative volume in the free state. Result : 6.94.

(D) Subtract the combining volume 7.13 from the original volume. Result : - 0.19

(E) Multiply this change of volume by the atomic weight 55 and also by 120, which is the constant for all elements of atomic weight greater than 22, to find the H.F. Result : 1254

This operation may be expressed as follows :- Discover the Law of Heat of Formation.

(F)- Find the equivalent original volume of an atom of oxygen. Result : 10.07. This is a difficult operation because the O-atom is solid in the molecule, but gaseous in the free state, so that latent heat has to be considered. The word "equivalent" denotes that if the atom were solid in the free state its volume would have been 10.07.

(G)—Subtract the combining volume 7.53 from the original volume 10.07. Result :- 2.54.

(H)--Multiply this change of volume by the at. wt. 16 and also by 795, which is the constant for sub-sodium elements. Result : - 32311

(I)--Subtract the combining volume 2.51 from 10.07. Result : 7.56

(K) Multiply 7.56 by 16 and 795. Result : 96155.

(L) Add together the three results of (E), (H) and (K) in order to obtain the H.F. of MnO_2. Result : 127242. Obs. 126000 and 125300. This result must be considered correct if it is within 2000 of the experimental result; because the experimental values for any particular substance frequently differ by more than 2000.

The fact that the original volume of Mn is 11.53 in three cases out of four makes it quite certain that there is no mistake for a reason exactly similar to that recently given in the summary of the paper on magnesium.

Each numbered line in this and all preceding papers contains a distinct numerical discovery.

In addition to the proof that Mn = SiAl this paper accomplishes many other objects which have frequently been stated in the summaries of other papers. The only one which will be especially alluded to here is that of the continuation of the demonstration that water of crystallisation absorbs 8205 calories when formed from liquid water (Nos. 69, 70, etc.).

ON ORGANIC COMPOUNDS OF ARSENIC. PART II. REACTION BETWEEN THE GRINGARD REAGENT AND ARSENIC TRIOXIDE.

By Kaoru Matsumiya and Minoru Nakai.

Abstact.

The action of arsenic trioxide on the Grignard reagent was studied. On treating arsenic trioxide with phenylmagnesium bromide, triphenylarsine and diphenylarsine oxide were obtained; with p-tolymagnesium bromide, tri-p-tolylarsine and di-p-tolylarsine oxide were isolated; with α-naphthylmagnesium bromide, di-α-naphthylarsine oxide wre formed. On boiling the ethereal solution of methylmagnesium iodide with di-α-naphthylarsine oxide, methyl-di-α-naphthylarsine was produced. From these facts, the authors have come to the conclusion that Sachs and Kantarowitz's views about the reaction (*Ber.*, 41, 2767(is incorrect, and that the reaction should rather be regarded as taking place according to the following equation :-

$As_2O_3 + 4RMgBr = (R_2As)_2O + 2MgO + 2MgBr_2$; $(R_2As)_2O + 2RMgBr = 2R_3As + MgO + MgBr_2$.

The following compounds were isolated and examined: di-α-naphthylarsine oxide $[(C_{10}H_7)_2As]_2O.H_2O$, white crystalline powder, M.P. 240-241°; di-α-naphthylarsine trichloride, $(C_{10}H_7)_2AsCl_3$, yellow crystalline powder; di-α naphthylarsinic acid, $(C_{10}H_7)_2AsO.OH$, white amorphous powder, M.P. 228-229°; methyl di-α naphthylarsine, $(C_{10}H_7)_2As.CH_3$, colourless needles, M.P. 145-146°; and di-α-naphthylarsine oxychloride, $[(C_{10}H_7)_2AsCl_2)]_2O$.

The melting points of p-tolylarsine compounds were found as follows: tri-p-tolyl arsine 146-147°, di-p-tolylarsine oxide 105-106 and di-p-tolylarsinic acid 173-174°.

(Memoirs, College of Chemistry, Tokio University.)

Trade and General Notes.

REMOVAL OF FOREIGN LOANS EMBARGO.

The Federation of British Industries desire to express their gratitude to the Government authorities of the country for the removal of the "embargo" on the issue of foreign loans in this country.

They suggest, as preliminary steps, that His Majesty's Government should make it clear that no country with an unstable currency will be permitted to obtain any loan in the British market, except, of course, a loan contracted for the express purpose of currency stabilisation. They further consider that where countries with unstable currencies are indebted to Great Britain no arrangement concerning these debts which involves any concession to the debtors should be concluded until the most definite guarantees have been given by the government of the country concerned that they will stabilise their currency without delay.

INTERNATIONAL COMBUSTION, LTD.

Messrs. International Combustion, Ltd., of Africa House, Kingsway, have informed us that their associated company of New York, the Combustion Engineering Corporation, received orders for the following plant during the month of September, 1925:—

One complete "Lopulco" pulverised fuel plant for Canadian International Paper Co., Three Rivers, Quebec, including three air heaters and three fin furnace walls.

Also other contracts including 33 boilers totalling 127,000 square feet, together with combustion equipment.

POTATO CULTURE.

An important conference was held on November 20 at Rothampsted Experimental Station.

Sir John Russell, director of the Rothamsted Station, said that in contemplating the decline of arable cultivation in this country in the last 60 years, the potato crop offered a ray of comfort. Its acreage had increased from 355,000 to 507,000, and its production from 2,750,000 tons to 4,000,000 tons. He uttered a warning against too rapid increase, however, in consequence of the fall in price resulting from a glut. In considering manuring, three factors had to be borne in mind. In the first place it was essential that there should be sufficient air space and moisture in the soil to allow the tubers to grow. Secondly, disease was a more important factor for potatoes than any other crop; scab was associated with an alkaline soil, and blight with over-manuring with nitrogen and under-manuring with potash. In the third place, variety and climate set definite limits to yield. Farmyard manure should be the basis of all potato manuring, since it increased the air and moisture supply of the roots. It was best applied in the autumn, as it then had time to rot and supply this air and moisture in the spring. Trials were wanted, however, to determine relative values of autumn and spring applications. Investigations were proceeding with regard to the value of gree manuring as a substitute for dung.

As regards artificials, it could safely be said in general that 1 cwt. of sulphate of ammonia would increase the yield of potatoes by one ton per acre, at Rothamsted good returns had been received to applications as high as 8 cwt. Superphosphate improved the root action, but it was not essential for the English crop on all soils. An ample supply of potash was important for yield, health, and quality of crop. Sulphate of potash in general was better for quality than chloride of potash.

Mr. J. C. Wallace, agricultural organiser

for Holland (Lincs.), described his experiment on the silty "fen" soil of that county, while Mr. R. W. Wheldon, of Armstrong College, Newcastle-on-Tyne, dealt with experiments at six centres in the North carried out by that college, chiefly as regards comparative effects of sulphates of ammonia and potash on the one hand and chlorides on the other. The sulphates produced earlier and longer growth. He concluded that 3 cwt. sulphate of ammonia and 3 cwt. sulphate of potash could profitably be used in the North.

Mr. T. Eden, of the Rothamsted Station, spoke of the station's results. His general conclusions were that dung was beneficial to the yield, but not so much to quality, except where low-grade potash salts were included in the artificials; that potash paid well in most forms, except as very low-grade salts; and that nitrogen always paid up to certain limits.

ALMOND PASTE AND KERNEL PASTES.

FOOD INSPECTION DECISION 197,
(*U.S.A., Department of Agriculture*).

The following definitions and standards for almond paste and kernel pastes were adopted by the Joint Committee on Definitions and Standards, composed of representatives of the United States Department of Agriculture, the Association of American Dairy, Food and Drug Officials, and the Association of Official Agricultural Chemists, at its meeting July 13 to 17, 1925:

Almond Paste is the plastic product obtained by cooking blanched and ground sweet almonds with blanched and ground bitter almonds, sugar, and water. It contains not more than fourteen per cent. (14%) of water nor more than forty per cent. (40%) of total sugars expressed as invert sugar.

Kernel Pastes are the plastic products obtained by cooking, with sugar and water, the blanched and ground kernels of one or more of the following: Apricots, peaches, plums (prunes). They are free from hydrocyanic acid and contain not more than fourteen per cent (14%) of water, nor more than forty per cent. (40%) of total sugars expressed as invert sugar. A kernel paste conforms in name to the kind or kinds of kernels employed in its production.

The foregoing definitions and standards are adopted as a guide for the officials of this department in the enforcement of the Federal food and drugs act.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Thursday, December 3, 1925, at 4.30 p.m.
The following papers were read:

Studies in Catalytic Combustion. Part II. The Union of Carbon Monoxide and Oxygen in Contact with Nickel, Copper and other Oxides, by W. A. BONE, F.R.S., AND G. W. ANDREW.

Immobile Groups of Atoms with Strong Specific External Fields as the Cause of Catalytic Activity, by F. H. CONSTABLE. Communicated by Sir William Pope, F.R.S.

On the Law and Mechanism of Monomolecular Reaction, by S. C. ROY. Communicated by Prof. O. W. Richardson, F.R.S.

The Effect of Temperature on the Viscosity of Air, by F. A. WILLIAMS. Communicated by Prof. H. B. Dixon, F.R.S.

Gaseous Combustion at Medium Pressures. Parts I. and II., by R. W. FENNING. Communicated by Dr. T. E. Stanton, F.R.S.

The Kinetic Theory of Surface Films. Part II., by R. K. SCHOFIELD AND E. K. RIDEAL. Communicated by Sir William Hardy, Sec., R.S.

ROYAL SOCIETY AND ROYAL SOCIETY OF ARTS.

In the course of a comprehensive paper on Scientific Research, before the Royal Society of Arts on November 4, Sir Thomas H. Holland, D.Sc., F.R.S., etc., said:—

"All movements in this country having for their object the correlation of activities in scientific research were, until the end of last century, purely voluntary. 'The Royall Society of London for improving Naturall Knowledge,' which is still the recognised leader, commenced its

corporate life on the 15th July, 1662, and grew out of a small body, who, on the 5 December, 1660, made an agreement 'to meete together weekely to consult and debate concerning the promoting of experimental learning,' each paying 'one shilling towards the defraying of occasional charges.'

SOCIETY OF ARTS.

The Royal Society in its earliest days included papers on technical and industrial subjects, as well as papers on pure science; but its recognition of the applied side of science became insufficient to meet the demands which accompanied the industrial revolution and commercial expansion of the 18th century. The Society of Arts was consequently founded in 1754, and has, during the subsequent 171 years, maintained its position, without restriction of scope, as a voluntary association of those interested in turning the results of science in all its branches to account for the 'encouragement of Arts, Manufactures and Commerce.'

The curve showing the Society's expansion has occasionally steepened beyond its average slope, but has only once seriously sagged, and that was immediately preceding a period of rapid growth which was genetically connected with the evolution of our existing system for correlating research activities throughout the empire. This period of remarkable activity was during the two decades following 1848, when the Prince Consort accepted the office of President, and took an active interest in the work of the Council until his death in 1861.

Two movements which were then originated by the Society have done more than any other instances of the sort that I can recall to stimulate national consciousness to the value of applied science, and both of these occurred in 1851 the Great Exhibition and the union of so-called mechanics' institutes, with its accompanying system of uniform examinations.

The success of the system of provincial examinations led to imitations, or rather specialised developments, which in their own way have been equally useful in stimulating the study of applied science, namely, those afterwards instituted by the Science and Art Department and those commenced in 1879 and still conducted in technology by the City and Guilds Institute. The old Science and Arts Department served its purpose and gave way to other systems; and the City and Guilds Institute has extended its influence to overseas parts of the Empire and now examines some 8,000 students annually.

In the control of examinations the Society, as in other activities, adopted the policy of standing aside in favour of each specialised organisation. That it has been wise in thus curtailing its programme for the benefit of others, is shown by the later history of its examinations. Sir Henry Trueman Wood expressed satisfaction that the numbers of our examinees rose from under 10,000 in 1900 to nearly 30,000 in 1913. It must be some satisfaction to him to know that his successor's burdens are not lightened; for the examinees have since increased in numbers and last year reached the heavy total of over 70,000."

THE CHEMICAL SOCIETY.

The Constitution of the Metallic Ozonides, by E. C. C. BALY AND R. W. RIDING.

Ozonides of mercury, sodium, barium, zinc, cadmium, tin, lead and bismuth have been prepared. Mercury ozonide is obtained by the action of ozone on mercury, and the remaining compounds are obtained either by the action of the more electropositive metal on mercury ozonide, or by oxidation of the metal in mercurial solution by dry CO_2-free air. All are solids with a metallic fracture and on trituration in air tend to dissociate into the metallic oxide and free mercury. Silver does not form an ozonide.

Studies of Dynamic Isomerism. Part XX. Amphoteric Solvents as Catalysts for the Mutarotation of the Sugars, by T. M. LOWRY AND I. J. FAULKNER.

Velocity-concentration curves are given for the mutarotation of glucose in mixtures of pyridine and water and for tetramethylglucose in mixtures of pyridine and water and of pyridine and cresol.

Pyridine, which is inactive when dry, gives, in solutions containing about 2 parts of water to 1 part of pryidine a maximum velocity, which is approximately twenty

Cresol is also inactive when dry, but when mixed with pyridine in the ratio of about 2 parts of cresol to 1 part of pryidine, it gives a maximum velocity approximately twenty times as great as that in pure water.

Studies of Valency. Part V. Absorption-spectra of Halogen and Sulphonic Derivatives of Camphor. Origin of the Ketonic Absorption-band, by T. M. LOWRY AND G. OWEN.

Quantitative data are given for the general and selective absorption of 20 halogen and sulphonic derivatives of camphor.

Halogen atoms in the α-position intensify both the general and the selective absorption; but halogen atoms and sulphonic groups in the β or π position are relatively impotent.

*Studies of Valency. Part VI. General and Selective Absorption of Halogen-*Derivatives of Methane. The Origin of *General Absorption*, by T. M. LOWRY AND (MISS) R. R. SASS.

Quantitative data are given for the general and selective absorption of nine halogen-derivatives of methane. The general absorption increases with the number of halogen atoms, and with the molecular weight of the halogen, until it passes into a selective absorption in the iodides.

Studies of Valency. Part VII. Surface Polarity and the reaction of ethylene and chlorine. The Effect of the Adsorbed Water Layer, by R. G. W. NORRISH AND G. G. JONES.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the meeting held on Friday, November 13, 1925, at the Imperial College of Science. F. E. Smith, C.B.E., F.R.S., President, in the chair.

Dr. W. H. Eccles proposed and Dr. E. H. Rayner seconded a vote of congratulation to Mr. F. E. Smith on the recent presentation to him of the Hughes Medal of the Royal Society. The vote was carried by acclamation.

A paper, *On the Viscosity of Ammonia Gas*, by R. G. EDWARDS, A.R.C.Sc., B.Sc. D.I.C., AND B. WORSICK, A.R.C.Sc., B.Sc., D.I.C., was read by Mr. Edwards.

ABSTRACT.

The viscosity of ammonia gas has been determined at three different temperatures by transpiring the gas through a capillary tube which had previously been calibrated with air. Sutherland's constant is found to be roughly 370, and the mean collisional area of the ammonia molecule 0.633 $\times$ 10^{-15} sq. cm.

DISCUSSION.

Prof. A. O. Rankine said that in published tables of physical constants the values given for different temperatures have often been obtained by different methods and cannot, therefore, be safely used for studying the variation of a given property with temperature. Hence it is important to apply any given method over as wide a range of temperatures as possible. The authors had covered a range of about 170° C., which was very satisfactory.

Mr. F. E. Smith said that the authors' work is a valuable indication that the transpiration method is a simple and reliable one for determining viscosities.

A paper entitled, *Valve Maintained Tuning Forks Without Condensers*, was read by T. G. Hodgkinson, A.M.I.E.E. The paper was illustrated by a demonstration.

ABSTRACT.

The valve maintained tuning fork is now a much-used piece of apparatus, but the influence of the conductance of the valve electrodes on the design has not been considered. The present paper discusses the design of valve maintained tuning forks without condensers and shows that the conductance of the valve grid decides the direction in which the electrode coils must be wound; and also that it is advantageous, particularly in the case of low frequency forks, to interpose transformers between the valve electrodes and the fork magnets.

DISCUSSION.

Dr. W. H. Eccles said that every one who wishes to use valve maintained forks with precision must read Mr. Butterworth's paper on the subject, but that paper does not explain the ambiguity which exists as to the direction of winding of the grid coil. This puzzle has been cleared up by the author, who has also shown how account must be taken of the valve characteristics in designing the apparatus, and how to secure that the maintained frequency shall be the true frequency of the fork. The latter point is particularly important when the harmonics of the fork frequency are employed: thus it is possible to utilise the twenty-ninth harmonic of a 1,000∞ fork, giving a frequency of 60,000∞. In this way standards can be obtained and oscillations generated over a wide range of the

wireless spectrum, at constant and accurately grown frequencies.

Dr. C. V. Drysdale said that he had long been interested in stroboscopic methods of measurement, but these had always suffered from the defect that the rate of a fork is varied by the means adopted for maintaining vibration. Dr. Eccles' invention of the valve-maintained fork was of great importance as a solution of this difficulty, and the author was to be congratulated on having put the matter on a satisfactory quantitative basis.

The author, in reply to the discussion, said that he had not discussed the use of harmonics of the fork note, as he had been concerned with the problem of producing a low frequency note in imitation of the noise of an aeroplane. The difference between the maintained note and the true fork could easily be reduced by employing tuning condensers, which he had not considered in his paper. In any case there are factors ,such as the filament current, which are not taken into account in the theory, but may effect the frequency. The effect of these could no doubt be reduced to any required extent by incorporating tuning condensers in the transformer coupled system.

A paper entitled *The Times of Sudden Commencements (S.C.s) of Magnetic Storms: Observation and Theory*, was read by C. Chree, Sc., LL.D., F.R.S.

ABSTRACT.

An earlier paper (*Proc. Phys. Soc.*, Vol. 26, 1914, p. 187) discussed a number of data for the times of occurrence of the "Sudden Commencements" (S.C.s) of magnetic storms which had been published by Dr. L. A. Bauer in "Terrestrial Magnetism," and came to a conclusion adverse to Dr .Bauer's claim that S.C.s were propagated from east to west or west to east, with velocities of from 100 to 200 kilometres per second. Since that date papers on the subject have been published by Prof. S. Chapman and Fr. Rodés, of the Ebro Observatory, propounding theories differing from one another and from Dr. Bauer's. In a recent paper, Dr. Bauer and Mr. W. J. Peters have re-discussed the subject. They conclude that the motion in longitude is much more rapid than according to Dr. Bauer's original estimate, and suggest that it is really a case of propagation from the magnetic equator towards either magnetic pole.

The Section of Terrestrial Magnetism and Electricity of the International Union of Geodesy and Geophysics has recently approved a scheme aiming at the construction and use of special instruments to find out whether S.C.s have a finite rate of propagation. The present paper discusses the whole subject, partly with a view to facilitating a decision as to the new apparatus and the stations most suitable for the investigation.

DISCUSSION.

Mr. F. E. Smith said that the expression "homogeneous data" appears to mean the same as "arbitrarily selected data," and physicists are indebted to the author for his strenuous insistence on a rigorously scientific examination of the theories that have been put forward. The type of apparatus required for settling the questions at issue would depend on the theory to be tested. A theory which postulates a comparatively slow rate of propagation of the sudden commencements could very easily be tested with the aid of wireless time signals, but if the time differences between the sudden commencements at different stations be very small, the problem becomes much more difficult.

A demonstration of "The Kinetic Properties of a Gas Jet" was given by Dr. J. S. G. Thomas.

The demonstration was designed to illustrate the Bernoullian property of a gas jet, which has a central region of low pressure. Gas discharged through a large orifice from a gas cylinder was employed. (*a*) The jet was directed downwards on to a plate, and it was shown that a ping-pong ball, instead of being blown away when placed on the plate, took up a position of stable equilibrium at the centre of the jet. The stability was demonstrated by inclining the plane on which the ball was supported: a considerable inclination failed to dislodge the ball. When brought near the orifice the ball flew up to this and adhered to it. (*b*) The jet was directed upwards and a toy balloon was thrown into it. The balloon then rested in stable equilibrium at a considerable height above the jet, and the equilibrium persisted even when the jet was inclined to the vertical. On insertion of the operator's hand into the jet so as partly to shield the balloon, the latter appeared to be attracted towards the hand; this phenomenon afforded an illustration of Le Sage's theory of gravitation.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Abstract of paper read:

The Engineer, by THOMAS CARTER.

THE RISE OF MODERN ENGINEERING.

The world has never been wanting in engineers. Almost before the dawn of history, Zillah, the wife of Lamech, "bare Tubal-Cain, the forger of every cutting instrument of brass and iron"; and his kind have always played a leading part in human development. The famous buildings of the past witness to the greatness of the engineers who created them; and the works of early races and of the Middle Ages sometimes put our own to shame.

The modern engineering profession has grown up within the last two or three hundred years as a consequence of the new interest in science and scientific investigation that arose in the sixteenth century. Sir Hugh Myddleton, who died in 1631 and who conceived the New River water scheme for London, has been called "the first English engineer"; and names of great men, like Newcomen, Brindley, Smeaton, Watt, Telford, Rennie, the Brunels, and the Stephensons, meet us in the succeeding period. Associations of engineers began to arise. "Before or about 1760," (quoted from the preface to Smeaton's Reports), "a new era in all the arts and sciences . . . commenced in this country . . . Manufactures were extended on a new plan . . . by men of deep knowledge and persevering industry engaged in them. It was perceived that it would be better for establishments to be set down in new situations . . . than to plagued with the miserable little politics of corporate towns, and the wages of their extravagant workmen." A demand arose for internal navigation as a means of communication, and "this general situation . . . gave rise to a new profession and order of men, called Civil Engineers." Some of these engineers used to meet in the Houses of Parliament and in the Courts of Justice, without knowing much of each other, and someone proposed to Smeaton that "it would be well if some sort of occasional meeting, in a friendly way, was to be held, where they might shake hands together, and be personally known to one another; that thus the sharp edges of their minds might be rubbed off, as it were, by a closer communication of ideas, in ways naturally hostile; might upon which they should happen to meet promote the true end of the public business in the course of their employment; without jostling each other with rudeness, too common in the unworthy part of the advocates of the law, whose interest it might be to push them on perhaps too far in discussing points in contest. . . In March, 1771, a small meeting was first established, on Friday evenings, after the labours of the day were over, at the Queen's Head Tavern, Holborn. . . Conversation, argument, and a social communication of ideas and knowledge, in the particular walks of each member, were at the same time the amusement and the business of the meetings." In May, 1792, a disagreement caused the dissolution of the Society, but it was afterwards revived "in a better and more respectable form." The members dine together and passed the evening "in that species of conversation which provokes the communication of knowledge more readily and rapidly than it can be obtained from private study or books alone. The first meeting of this new institution, The Society of Civil Engineers, was held on the 15th of April, 1793." There were three classes of membership; Ordinary Members were real engineers, employed as such; men of science and gentlemen of rank, who might, for talents and knowledge, have been engineers, together with persons employed in kindred public service, formed one group of Honorary Members, and a second consisted of various artists, whose professions and employments were useful to civil engineering. The meetings were held at the Crown and Anchor, in the Strand, every other Friday during the session of Parliament, and an early list of members shows 12 real engineers, 10 of the first kind of Honorary Members, and 7 of the second, namely, a geographer, two instrument makers, a millwright, an engine maker, a printer, and a land surveyor. So much for this predecessor of all our present-day Institutions.

The Institution of Civil Engineers, established in 1818, and chartered in 1828, nobly defined the profession of a civil engineer, as "the art of directing the great sources of power in nature for the use and convenience of man"; The Institution of Mechanical Engineers began in 1847, and The Institution of Naval Architects in 1860; and the Society that grew into the Institution of Electrical Engineers was founded in 1871, as a mark of the progress

of the new science that began to find its modern application when Faraday discovered the existence of electro-magnetic induction in 1831. The engineer of to-day has the whole range of natural forces to deal withlli and in no department of his profession is the variety so great as amongst electrical engineers. Our Institution has for its members some who roam at will in the tiny empty space between the nucleus and the electrons of an atom, not only seeing with some special vision the wonderful processes of that region, but actually taking matter to pieces and remaking it differently; some who, at the opposite end of the scale, construct machines so large that one of the mwill keep the wheels turning for thousands of workers; some who take these machines and build them into power stations; some who run these power stations, and test them complete as a single machine used to be tested, always endeavouring to make more and more use of the energy of their fuel; consultants, who work out schemes for the application of electric power; public advisers who regulate and co-ordinate the electrical resources of the country; those who instal plant and wire buildings; those who teach others; those who control communication with and without wires; those who made that kind of communication possible; and many others. All these are engineers, every one in his own sphere trying to direct some great source of power in nature for the use and convenience of man.

JUNIOR INSTITUTION OF ENGINEERS.

Dehydration of Tar, by G. E. Wills.

On Friday, November 20, Mr. G. E. Wills delivered a lecturette on the subject of the "Dehydration of Tar."

With the aid of slides, Mr. Wills described some of the types of tar distilling and dehydrating plants, pointing out the different forms of stills designed to prevent priming, and the arrangements made for pre-heating the crude tar and condensing the distilled vapours. The first illustration was a diagrammatic representation of the cascade type of still, in which the crude tar is allowed to run as a thin film over a number of overlapping plates fitted in the tank above the level of the tar in the bottom. The tar falls over the last plate into the body of the liquid, and is run off into another tank fitted with a coil in such a way that heat is transferred from the dehydrated tar to the crude tar entering the still. The volatile matter which is distilled is passed through a water condenser and separator to storage tanks.

Other plants which Mr. Wills described showed variations in the design of still and in the manner of pre-heating. In some the crude tar was pre-heated by the flue gases from the still furnace, and in others by being passed through the condenser in place of water.

The Road Department specifications for tar were shown, and Mr. Wills indicated the methods of testing the viscosity, etc. After the conclusion of the leaturette, some discussion centred on the effect of free carbon as one of the constituents of tar. Mr. W. Kirby said that a fair proportion of carbon was desirable in tar for road work because it had binding power and resisted cracking. He said that the general opinion was that 10 to 20 per cent. was an advantageous amount.

NOTICES OF BOOKS.

Trattato di Chimica Generale ed Applicata all' Industria, by Prof. E. Molinari. Vol. I., Chimica Inorganica, Part 2. Pp. VIII. + 681-1352. Fifth Edition, revised and enlarged. Milan: Ulrico Hoepli. 1925. Price, 40 lire.

Among Italian technical books, Molinari's Treatise on General and Applied Chemistry has attained a high rank, and may be included among the classics on industrial chemistry.

Its importance may be estimated by the fact that the English translation by T. H. Pope ,B.Sc., F.I.C. (published by Messrs. Churchill) is so well-known to analysts and industrial chemists. The original edition will, therefore, have but a limited appeal to English chemists, comparatively few of whom have a good knowledge of Italian. Those familiar with French will not find it difficult to follow, and it can be conconsulted with confidence for valuable information on many subjects.

The work has evidently been revised with care, but although under Arsine (*Idrogeno arseniato*), p. 682, reference is made to the solid As_4H_2, no mention is made of the better-known As_2H_2.

Statistics have also been amended and extended. So far as the last few years are concerned, they are naturally very incom-

plete and fragmentary. It is difficult to see how this can be avoided. There is a "hysteresis" as regards industrial information from Russia, and figures for the prewar and post-war Austria have very little significance.

The index in this volume covers both Parts 1 and 2.

The fifth edition of Prof. Molinari's work fully maintains the high standard of its predecessors. J. G. F. D.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi.

December 9, at 4.30 p.m. (Joint Meeting of the Indian and Dominions and Colonies Sections.) A paper on "The Imperial College of Tropical Agriculture," by H. Martin Leake, M.A., Sc.D., F.L.S., Director of the College, will, in the absence of the author, be read by Arthur William Hill, Sc.D., F.R.S., Director, Royal Botanic Gardens, Kew. The Rt. Hon. L. S. Amery, M.P., Secretary of State for the Colonies, will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London, W.C.2.

ARRANGEMENTS FOR FIRST PART OF SESSION, 1925-26.

Ordinary meetings of the Institution Thursdays at 6 p.m. Light refreshments, 5.30 p.m.

7 Jan. Capt. P. P. Eckersley, "Past, Present and Future Developments in Wireless Telephony."

21 Jan. Subjects to be announced later.

4 Feb.— " " " "

LIVERPOOL UNIVERSITY SCHOOL OF CHEMISTRY.

The annual soirée will take place on December 4 at Brownlow Street. Reception, 6.30-7 p.m., by Professor and Mrs. Baly. An address will be given by Professor G. G. Henderson, D.Sc., F.R.S., on "The Chemist and the Community."

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Eighty-ninth general meeting at the House of the Royal Society of Arts, John Street, Adelphi, W.C.2.

On Tuesday, 8 December, 1925, the following paper will be read at 5.30, "The Selection and Properties of Steels used for Oil Well Boring Equipment," by J. H. S. Dickenson, F.Inst.P., B. Gray, B.A., and F. E. Cherry, M.Inst.P.T.

ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Monday, December 7, 1925, at 5 p.m. General meeting of the Members.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

28,082. Badische Anilin & Soda Fabrik. Manufacture of iron carbonyl. November 18th.

28,408. Ross, G. Process of roasting sulphur-containing ores. November 11th.

Specifications Published.

226,491. Meyerhofer, R. F. Process of producing metal compounds.

242,018. France, R. Evaporation of solutions of salt or other substances to produce crystals.

237,864. Steffen, Junr., C. Washing process for the production of a tricalcium saccharate of high purity.

Abstract Published.

240,318. Sulphonic Acids; emulsifying agents, etc. Farbwerke vorm. Meister, Lucius & Brunning; Hoechst-on-Main, Germany.

Water-soluble condensation products, suitable as such or in the form of salts for use as frothing or emulsifying agents for example in dyeing and pharmacy, are produced by the action of an aralkyl halide or of an aryl halide containing reactive halogen, such as benzyl chloride, xylyl bromide or dichlordihydronaphthalene, upon a sulphonic acid of an aromatic polynuclear hydrocarbon, such as naphthalene, methylnaphthalene, tetrahydronaphthalene, anthracene, etc., in the presence of sulphuric acid, or alternatively by the action of a powerful sulphonating agent, such as oleum or a mixture of oleum and chlorsulphonic acid, upon the condensation product of such a halide and the hydrocarbon itself or upon such reagents before condensation. It is stated that if the condensa-

tion product of the halide and the hydrocarbon is treated with ordinary concentrated sulphuric acid, further condensation takes place to a hard, insoluble resin. In examples naphthalene is sulphonated and the product treated with benzyl chloride at 120-170° C. the mass poured on ice, diluted with water and either treated directly with caustic soda, filtered and the solution evaporated or treated with lime, filtered and the evaporated calcium salt converted into the sodium salt. Benzyl chloride and naphthalene are condensed at 80-90° C. and the product treated with a mixture of oleum and chlorsulphonic acid, caustic soda added and the product dried and pulverised.

210,087. Formamide. Badische Anilin & Soda Fabrik, Ludwigshafen-on-Rhine, Germany.

Formamide is made by the action of ammonia on an alkyl formate at a pressure exceeding atmospheric pressure. Liquid ammonia is preferably used, but gaseous ammonium or a strong aqueous ammonia may be employed; in the latter case more or less ammonium formate is formed at the same time. When the pressure is released the heat of the reaction serves to evaporate the alcohol formed, leaving a residue of nearly pure formamide. Methyl formate, which may be obtained by the action of carbon monoxide on methyl alcohol or as a bye-product in the catalytic hydrogenation of oxides of carbon to methyl alcohol, is the alkyl formate preferably employed. The alkyl formate may be produced in the same reaction chamber as the formamide by the action of carbon monoxide on methyl alcohol in the presence of an alkali metal or alcoholate; the ammonia required for the production of formamide being introduced at the same time or subsequently.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

MASTAN.

462,927.—Chemical substances prepared for use in Medicine and Pharmacy. H. R. Napp, Ltd., 3 and 4, Clement's Inn, Kingsway, London, W.C.2. November 11th.

BASEX.

460,764. Chemical substances for use in water softening processes. The Paterson Engineering Co., Ltd., Windsor House, 83, Kingsway, London, W.C.2. November 18th, 1825.

Publisher's Announcements.

The following Books can be obtained from Rea & Inchbould, Merton House, Salisbury Square, London, E.C.4.:

CONFESSIONS OF GREAT SOULS,

By the Rev. J. E. Roscoe, M.A.

This striking work gives extracts (with comments) from the opinions of 50 great writers and thinkers in all ages on Religion. These include Bacon, Balzac, Burns, Carlyle, Cicero, Dante, Darwin, Dickens, Emerson, Faraday, Homer, Huntley, Johnson, Longfellow, Maeterlink, Milton, Napoleon, Newton, Pope, Ruskin, Shakespeare, Socrates, Spenser, Thoreau, Wordsworth, etc., etc.

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(Author of *Dictionary of Educationists*, *Confessions of Great Souls*, *History of Theological Education*, etc., etc.)

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Various numbers, parts of Vols 117 and 118 (1918/19) are only on sale at 2s. 6d. each.

THE GENERAL INDEX TO VOLS. 1 to 100 can still be purchased at £1 1s. (Carriage Paid.)

All communications should be addressed to the Manager, CHEMICAL NEWS, Merton House, Salisbury Square, London, E.C.4.

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EKA-CAESIUM. (PART II.)

By F. H. LORING.

In this Journal, November 6, 1925, Dr. Druce and myself announced the existence of element of atomic number 87, which is eka-caesium, but the proof we supplied was meagre.

When I was making some projection experiments in Messrs. Adam Hilger's Research Laboratory, a faint line was noticed in the Br-Ag absorption region on the film containing the $L\alpha_1$ line, previously announced as belonging to the above element.

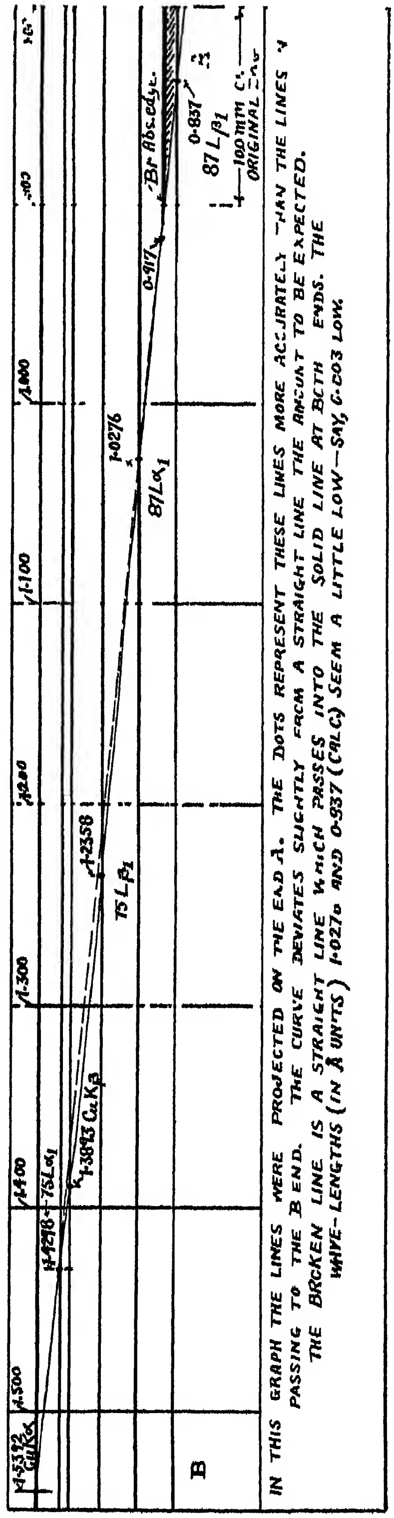
The instrument used was one of Messrs. Hilger's spectrum comparators, giving an enlargement of 8.5 diameters.

In the present case, the film containing the $L\alpha_1$ line of 87 was projected on a sheet of drawing paper, and the positions of all the lines marked thereon. Ordinates were drawn through the marks, and the proper values (see this Journal, November 27, 1925, Table II., p. 339) were measured off and inserted. It was found that when this was done, the faint line was intersected at the correct value for the $L\beta_1$ line of element 87 by the curve as here shown, which is practically a straight line.

Incidentally, at the same time we were able to compare a zinc line, $K\alpha = \lambda$ 1.434, with the $L\alpha_1$ line of element 75 of wavelength 1.4298, and the want of correspondence was observed, as expected. This is an accurate test, because the two films were taken with the same setting of the spectrograph, and the characteristic copper lines matched exactly when projected on the screen by means of the above instrument.

It does not follow that the projection brings out faint lines, for as a rule they are best seen by the naked eye, but experienced observers can often recognise such lines by this means.

A Correction.—On page 340 of this Volume, half way down first column, delete the word "calculated" nearest to the end.



CARBON MONOXIDE POISONING.

By R. R. Sayers and W. P. Yant.
(*U.S.A. Bureau of Standards.*)

Carbon monoxide (CO) may be formed in many places and inhalation of this insidious gas is a frequent and widely distributed cause of poisoning that ranges in severity from headache and lassitude to unconsciousness and death. People are continually being affected by CO in homes and garages, around gas and gasoline engines and blast furnaces, in fighting fires, after blasting in mines and quarries, and after mine fires and explosions; in fact, at any place where there is possibility of exposure to the products of combustion of carbonaceous fuels or products. As cases of this type of poisoning often occur from the most unsuspected sources, and as the indicating dicating symptoms of CO poisoning, such as headache, nausea, dizziness, collapse, and unconsciousness are often attributed to other causes, it is essential to have suitable means whereby the true condition can be ascertained. Quick, accurate determination is not only of value for making diagnoses and giving proper treatment, but for investigating the causes and conditions under which the poisoning occurred, as well as providing means for examining doubtful atmospheres to prevent and guard against the recurrence of poisoning.

The only infallible diagnosis of CO poisoning is made by examination of the blood for carbon monoxide hemoglobin, HbCO, the compound which the gas forms with blood and through which it possesses noxious properties. A mere qualitative examination for this compound will indicate whether or not CO is present, but in view of the obvious desirability of knowing whether or not CO is the primary cause of the condition of the patient, it is necessary to make a quantitative determination of the HbCO present.

Methods have been devised for the quantitative analysis of CO when present in blood and in air in quantities large enough to be dangerous to the health and safety of a person. Some of them are suitable as to accuracy, yet all have some objectionable features in that they require elaborate and expensive apparatus, and special technique and training on the part of the analyst, or are too delicate and cumbersome for field use. The last factor is important in investigations pertaining to the cause, diagnosis, and treatment of this type of industrial and domestic accident.

The Bureau of Mines, in its investigation of many cases of industrial and domestic poisoning from CO, found it necessary to develop a method and apparatus that could be immediately taken to the scene of the poisoning, and which would give accurate results as to the CO in the blood and in the air. The method has been used frequently during the past two years in the investigation of fatal and non-fatal cases of poisoning from gas stoves ,automobile exhaust gases, and blast furnace gases; also in the analysis of air in vehicular tunnels and in mines after blasting and during rescue operations after a mine explosion. It has been used in the laboratory for experimental investigation of CO poisoning of men and animals and has also been used with equal succes by other investigators and by corporations both in America and in foreign countries. In all of this work the method has been found very reliable and accurate, and admirably fulfills requirements for the examination of blood and air. Its simplicity and ease of operation make it well suited to the needs of hospitals, industrial surgeons, safety engineers, coroners, departments of public safety, boards of health and other allied organisations.

SULPHURIC ACID FROM A QUADRUPLE MIXTURE.

By Robert Saxon, B.Sc. (Vict.)

Ammonium iron sulphate, on electrolysis, yields ferric hydrate and sulphuric acid, there being a rapid ebullition of gas from both electrodes, ammonia and hydrogen at the cathode, and oxygen at the anode. The same current passed in series through ammonium ferrous sulphate, sees the same evolution of gases with that salt when the second mixture is copper sulphate and the ammonium ferrous sulphate. In the triple mixture, however, the deposited copper allows greater action, and after four hours' running tandem, there is a 9% solution of sulphuric acid in the NH_4Fe salt, and a 12% solution of sulphuric acid in the $CuNH_4Fe$ mixture. When a mixture of equivalent proportions of nickel, copper, ammonium, and ferrous sulphates be electrolysed in tandem with the same strength of ammonium ferrous sulphate, there is only a deposit of copper at first, without

nickel or ferric hydrates ,and the production of sulphuric acid is much more rapid than with the triple mixture. The deposit of copper on the cathode is even and tenacious, and seen through the green electrolyte, looks like steel, a case of complementary colours. As the copper sulphate disappears, the deposited copper asserts its colour, and would form a guide to the strength of the solution to an expert. When the copper sulphate has entirely disappeared the action slows somewhat. This stamps an easily displaceable metal like copper as best for the rapid formation of sulphuric acid.

Seven hours' running gives a 14% solution in the NH_4Fe mixture, and a 19% solution in the quadruple mixture, of sulphuric acid. In a second experiment, where the copper sulphate is in excess the evolution of gas increases in amount as more and more is dissolved and broken up, and three hours' running gives a 9% solution of sulphuric acid.

Methyl orange behaves with the quadruple mixture as with the triple one, but does not appreciably alter with the ammonium ferrous sulphate.

A CHEMICAL PROPERTY OF THE FOURTH DIMENSION.

By H. D. K. D.

A world consisting of parallel lines would appear unidimensional to its inhabitants, and to them the idea of " up " or " down " or " sideways " would be non-existent. The unidimensional inhabitants of a line could oscillate only backwards and forwards, and could thus, by establishing contact, become aware of one another's presence; they would be quite unable, however, to perceive the inhabitants of a parallel line, no matter how close to them, or even to conceive of the possibility of their existence. Dissymmetry in such an apparently unidimensional world would be a property of all objects whose ends were different, for such objects could not be made to correspond with their mirror-images owing to the impossibility of reversing an object upon its line.

Similarly, in an apparently bidimensional world, or a world of parallel planes, the inhabitants of a plane would be unaware of all other planes. Dissymmetric objects for them would consist of objects of which both the ends and the laterals were different, rendering impossible the rotation into correspondence of an object and its image, for the process of " turning over " would be inconceivable; they would immediately perceive that the " dissymmetric objects of the unidimensional world were not truly dissymmetric, for simple rotation would bring about coincidence between such objects and their images.

Thirdly, we ourselves, the inhabitants of an apparently tridimensional world, or a world consisting of " parallel spaces," are presumably located upon one of these spaces and are thus unable to conceive of the nature of the other " spaces " or to be aware of their inhabitants; and we are quite unable to visualise mentally the possibility of a real existence in worlds of higher or lower dimensions than our own. We are completely isolated by the fundamental character of our conceptive faculties. For us, a dissymmetric objects consists of anything whose ends, laterals and verticals are all different, rendering superposition upon its mirror-image impossible either by reversal, rotation, or turning-over, or by any combination of these processes. We immediately perceive, however, that the " dissymmetric " objects of the uni- and bi-dimensional worlds have no true dissymmetry, and we are able easily to visualise the multiplicity of the component parts of such worlds (the parallel lines and planes), a mental process which would be permanently impossible to their own inhabitants, just as for us the realisation of the true nature of higher dimensional components is permanently impossible.

So far, then, we see that in each world of higher dimensions, the inhabitants are able to perceive the complexity of parts of the lower worlds and to realise that the dissymmetric objects of such worlds are in reality symmetrical. Proceeding now to a world of four dimensions and employing the universal argument of analogy (upon which all knowledge ultimately rests), we must conclude that four-dimensional beings are such that they can easily conceive of the multiplicity of " spaces " of our three-dimensional world (of which we know only one unit), and can perceive the real symmetry of our so-called dissymmetric objects. They are able to make such objects correspond with their images by a revolution in the extra dimension.

For us, as chemists, then, the world of

four dimensions may be defined as *the simplest higher world in which the stereo-chemical law of Van't Hoff* no longer holds.* It follows also that, if there be no real distinction between a "dissymmetric" object and its mirror-image, from the viewpoint of a four-dimensional world, there can be none between the three-dimensional properties of such object and image. It may therefore be stated, also, that in the four-dimensional world a positive rotation of the plane of polarisation of light is identical with an equal negative rotation. Dextro- and laevo-tartaric acids, and the members of all other such pairs of optical enantiomorphs, are in reality identical one with the other. They appear to us to be different merely because we are unable to perform upon the molecule of either of them the simple operation of rotating it in the fourth dimension. To a four-dimensional being a Walden Inversion would reduce to a simple mechanical operation, were he provided with instruments delicate enough to enable him to handle the separate molecules.

H. D. K. D.

* Van't Hoff's law states that every dissymmetric molecule must represent an optically active molecule, of which the mirror-image must be the antipodal molecule. There are thus always two and never more than two, isomeric compounds having the "same" space structure.

ON THE LAW OF DEPRESSION OF FREEZING POINTS IN METALLIC ALLOYS.

By Kôtarô Honda and Toyozô Ishigaki.

It is a well-known fact that in solution, the law of depression of the freezing point holds good exactly and is usually employed for the determination of the molecular weight of a solute. In the case of alloys, it is generally believed that the above law does not exactly hold good, though Heycock and Neville[1] have already shown that in the case of binary alloys which form a simple eutectic with each other, this law is fairly well satisfied. In the case of binary alloys forming a solid solution, and also in that of an allotropic change in the solid phase, there is, so far as we are aware, no paper dealing with the confirmation of the law of depression or the elevation of the freezing point or the transformation point.

The theoretical deduction of the law of the depression of the freezing point was first made by Van't Hoff[2] and afterwards extended by M. Planck[3].

In a dilute solution, the change of the freezing point or the transformtaion point of a solvent due to a solute is given by

$$\delta T = \frac{RT^2(C_1 - C_s)}{m\lambda}$$

where R is the gas-constant, T the melting point or the transformation point of the solvent, C_1 and C_s the concentrations of the liquidus and solidus phases coexisting at a given temperature respectively, m the molecular weight of the solute and λ the latent heat of fusion or transformation of the solvent. In the case of binary alloys forming a simple eutectic, C_s is zero and hence

$$\delta T = \frac{RT^2C}{m\lambda}.$$

which is Van't Hoff's law. In the alloys forming a solid solution, C_1 may be greater or less than C_s. In the first case, the freezing point is lowered, but in the second case it is raised. The depression or elevation of the freezing point or of the transformation point for a great number of binary alloys has been already observed mostly in Tammann's Institute in Gottingen, Germany, and is published in *Zeitschrift fur anorg. Chemie*, and also given Landolt-Bornstein's table. From these data we have selected a number of alloys, whose change of freezing point seems to satisfy the above law. The depression or elevation of the freezing point was estimated from the case of the dilute solution.

Now, since in most cases, the latent heat of fusion of solvent metals is not exactly known, it is more convenient to calculate this from the observed depression of the freezing point, and compare the value so obtained with those previously determined.

Thus for alloys forming a simple eutectic, we use

$$\lambda = \frac{RT^2C}{m\delta T} = \frac{RT^2C'}{m_0\Delta T}$$

and for alloys forming solid solutions,

$$\lambda = \frac{RT^2(C_1 - C_n)}{m\delta T} = \frac{RT^2(C'_1 - C'_n)}{m_0\Delta T}$$

where C', C'_1 and C'_n are all the atomic percentage of the solute, and m_0 the atomic weight of the solvent.

The results of the present experiment may be summarised as follows: -

1. The lowering of the freezing point of pure metals is proportional to the concentration of the other element, which is dissolved in the former, provided the solution is dilute.

2. If the gram molecular weight of a solute is dissolved in a given solvent, then the depression of the freezing point (termed the atomic depression) is constant independent of the nature of the solute, whether it forms a solid solution with the solvent or not.

3. The lowering of the freezing point obeys the law of depression as given by Van't Hoff or Planck, that is,

$$\delta T = \frac{RT^2C}{m\lambda}.$$

or

$$= \frac{RT^2(C_1 - C_n)}{m\lambda}$$

4. As in the case of usual solution, the law can be used for the determination of the molecular state of the solute present in the solvent.

5. The same law is also applicable to the case of the transformations taking place in the solid phase.

(*Science Reports, Tohoku Imperial University.*)

[1] *Journ. Chem. Soc.*, PE, E892, 904; 57, 1890, 876; 71, 1897, 888.

[2] *Zeitschr. phys. Chem.*, 1, 1887, 488.

[3] *Thermodynamik, VII Auflage,* 1922, 262.

Trade and General Notes.

BRISTOL ELECTRICITY EXTENSION.

MILLION POUND SCHEME.

The million pound scheme for electricity extensions to the Bristol Corporation has been placed with Messrs. Vickers, Ltd., in conjunction with Messrs. Metropolitan-Vickers Electrical Co., Ltd., subject to the approval of the Electricity Commissioners.

BRITISH INDUSTRIES FAIR.

The special efforts which are being made by the Government to render the next British Industries Fair an unprecedented success are now bearing fruit. Many manufacturers throughout the country, appreciating the steps taken to attract overseas buyers in larger numbers than heretofore, and realising the facilities that the Fair affords for stimulating British trade and expanding their own business, are anxious to be represented at the Fair.

BEET SUGAR, FLAX AND QUARTZ IN CANADA.

THE BEET SUGAR INDUSTRY.

The production of sugar beets grown for beet sugar in Canada in 1924 according to the Dominion Bureau of Statistics, was 205,177 tons from 31,111 acres, an average yield per acre of 0.50 tons, as compared with 159,200 tons from 17,941 acres, or an average per acre of 8.87 tons in 1923. The total value of the roots grown in 1924 was $1,704,791, as compared with $1,922,668 in 1923. The total production of refined beetroot sugar in 1924 was 85,770,709 pounds, of the value of $6,192,645. In 1923 the corresponding figures were 89,423,160 pounds, of the value of $8,745,200. During 1924 two Canadian sugar beetroot factories were in operation. A third factory has been established at Raymond, Alberta, and will operate for the season 1925-26. The company reports that the acreage planted to sugar beets for this season was well over 6,000 acres and the total production is estimated at 58,000 tons, an average yield per harvested acre of 9.76 tons.

FLAX.

The year 1924 has been the most encour-

aging for Canadian flax growers since 1920. The growing and retting conditions in western Ontario, where practically all the Canadian fibre flax is at present produced, were very favourable, with the result that an exceptionally high yield of fibre and seed has been obtained. Some commercial areas have produced as high as 339 pounds of fibre and 16 bushels of mill-run seed per acre.

QUARTZ.

The production of quartz in Canada during 1924 totalled 150,896 tons, valued at $323,156, as compared with 264,076 tons, valued at $599,250 in the previous year, according to the Dominion Bureau of Statistics.

MARKING SALMON IN CANADA.

The Department of Marine and Fisheries has marked a considerable number of Atlantic salmon, by attaching silver tags to their dorsal fins, for the purpose of tracing the movements of these fish. A salmon that was marked and liberated of Burns Point, Port Maitland, Yarmouth County, Nova Scotia, on June 11th of this year, was killed in the Moisie River, Quebec, in the early part of July. If this fish took the most direct route, it travelled about 800 miles, but if it followed the larger indentations of the shoreline, it travelled over 1,200 miles.

NORTHAMPTON (LONDON) POLYTECHNIC INSTITUTE.

The annual distribution of prizes and certificates was held at the Institute, St. John's Street, E.C.1., on December 2. The Rt. Hon. Lord Montagu of Beaulieu was on the programme for performing this function. The conversazione for members, students, and their friends, was continued on the following day.

CHEMICALS FOR ROUMANIA.

We have been informed by the Department of Overseas Trade that the Direction Générale of the Roumanian State Monopolies are inviting tenders for the supply of chemicals of various kinds, the adjudication to be held on 12th December, 1925, at 11 a.m., in the offices of the Direction at Bucarest.

United Kingdom manufacturers desiring further particulars of this call for tenders should apply to the Department of Overseas Trade, 35, Old Queen Street ,and of the specification of the various chemicals required may be inspected.

CRUDE PETROLEUM IN CANADA IN 1924.

Crude petroleum production in Canada during 1924, as reported by the Dominion Bureau of Statistics ,amounted to 160,773 barrels valued at $467,400, while during the preceding twelve months, 170,169 barrels valued at $522,018 were produced. Drilling activity, continued in the Coutts-Sweetgrass and Wainwright fields of Alberta. In Ontario, the production from the Romney well of approximately 3,000 barrels, encouraged the drilling of several more wells to penetrate the Trenton formation.

AUTOMOBILES IN CANADA.

Registrations of passenger automobiles in Canada numbered 573,975, of trucks, 55,572, and of other motor vehicles 22,574, giving a total of 652,121 registrations in 1924 as compared with 586,850 in 1923.

In 1924 the 11 automobile factories in Canada produced 98,245 passenger cars, 18,043 trucks and 16,172 chassis, a total of of $88,210,418; this was a decrease of 10 132,460 cars with an aggregate selling value per cent. from the 1923 production of 147,202 cars valued at $96,614,176, according to a statement issued by the Dominion Bureau of Statistics. Raw materials cost 64 millions were used.

COAL DUST EXPLOSIONS.

A paper on "Coal Dust Explosions: The Effect of Release of Pressure on their Development," by H. P. Greenwald and R. V. Wheeler, just published, is the second joint publication by the United States Bureau of Mines and the Safety in Mines Research Board. It describes work carried out at Eskmeals during the summer of 1924, when Dr. Wheeler, the Director of the Experimental Station, had the assistance of Mr. H. P. Greenwald, Assistant Physicist on the Bureau of Mines staff.

The results obtained have a direct application to actual coal mining conditions, for they shew clearly that there is less danger of a coal dust explosion developing from a given source of ignition at a longwall face that at a "dead-end" or cul-de-

sac; and, generally, that branch roads near the point of ignition of an incipient coal dust explosion, by affording release of pressure, retard and may prevent the development of the explosion. Again, the course of a partially developed explosion may depend upon the arrangement of the mine roadways and branching passagesfi a knowledge of which will indicate the positions in the mine at which the most stringent precautions should be taken against the accumulation of coal dust or the occurrence of a source of ignition.

BRITISH MIGRATION: JANUARY SEPTEMBER.

Emigrants of British nationality from the United Kingdom to places outside Europe during the first nine months of 1925 exceeded immigrants into the United Kingdom from those places by 58,580. The outward totals for the corresponding period of 1924 and 1923 were 58,150 and 149,202 respectively.

BRITISH STANDARD VOLTAGES.

The British Engineering Standards Association has recently issued a revised edition of the B.E.S.A. Publication No. 77 Standard Voltages for New Systems and Installations. Most engineers are familiar with British Standard Specification No. 77, which was first published in 1921, and set forth the standard voltages for new systems and installations. In that document two stardard low voltages were laid down, namely, 220 volts D.C. and 240 volts A.C. At the time when the matter was first discussed, a great effort was made to standardise one low voltage only for both D.C. and A.C. circuits, but this was not then found to be possible. Now, however, after some years' experience and further development in the industry, it has been found possible to reach agreement on the basis of one low voltage. The Electricity Commissioners, the Institution of Electrical Engineers, and the large industrial and supply organisations have been consulted, and also the local Committee of the B.E.S.A. abroad, where the proposal has met with very general approval. The new document lays down 230 volts D.C. and A.C. as the standard low voltage for new systems. It is hoped that the new standard voltage will be employed in this country for all new systems and installations.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read on Thursday, December 3, 1925, at 4.30 p.m.:

Studies in Catalytic Combustion. Part II. The Union of Carbon Monoxide and Oxygen in Contact with Nickel, Copper, and other Oxides, by W. A. BONE, F.R.S., AND G. W. ANDREW.

The paper embodies the results of the authors' experiments upon the union of moist carbon monoxide and oxygen in contact with (i) nickel gauze at 365° C., (ii) copper gauze at 158° and 250° C., (iii) granular nickel oxide at 150° C., and (iv) granular copper oxide at 165° to 175° C., respectively.

In the case of nickel it is shown that the formation of a highly reactive Ni-CO (or possibly O-Ni-CO) complex in the surface layer is, or in refinable cimcumstances may become, a prime factor in the catalytic combustion. There were also other features of the experiments which suggested that the action of the metal may really be of a dual character, involving on the one hand (a) the "activation" by the metal of the two gases marker by a comparatively low rate of CO_2-formation, and on the other hand (b) the intermediate formation of still more reactive CO-Ni-O complexes.

In the case of a freshly reduced copper it is shown that although a volatile Cu.CO complex is, or may be, formed at the surface at such temperatures, the most vigoroxidation of the carbon monoxide took place when it was "activated" merely by "occlusion" in the metal (*i.e.*, before it assumed a copper-carbonyl form), in which condition it readily combined with similarly "occluded" and "activated" oxygen, and that, for the real "catalytic" reaction, no prior formation of either copper oxide or any Cu.CO complex was required, but only the "occlusion" of the respective gases.

In the case of the oxides of nickel and copper, the catalytic action is shown to depend upon the formation at the surface of an "activated" O film probably of more than monomolecular thickness. This film not only oxidises the carbon monoxide, but also effectively prevents the latter from penetrating to the underlying oxide surface and reducing it.

Taken as a whole, the experiments described in the paper constitute a strong body of evidence supporting the supposition that the real catalytic combination of carbon monoxide and oxygen over the surfaces in question is a process different from, and independent of, either the oxidation of a primarily formed " carbonyl " film or the reduction of a metallic oxide. It probably only involves the " activation " by " occlusion " of the respective gases, in the case of the two metals examined, whilst in the case of the other oxides it involves the formation of an active O film at the surface.

Immobile Groups of Atoms with Strong Specific External Fields as the Cause of Catalytic Activity, by F. H. CONSTABLE. Communicated by Sir William Pope, F.R.S.

In view of the fundamental importance of a precise knowledge of the nature of the small areas of solid surfaces which are catalytically active, a study has been made of the physical conditions under which active copper may be prepared.

Copper surfaces made by electrolytic deposition, reduction of alkaline copper solutions, and by hammering and polishing, were found to have an activity probably less than 1/0,000th that of the reduced metal. When the surface was produced by sudden cooling of the vapour, or by thermal decomposition of copper salts of organic acids, or by reduction of copper oxides, a markedly active product was obtained. The passage of ammonia gas over the metal at 820° C., produced some activation. The physical appearance of the surfaces varied from a metallic colour, through dull yellow to red-brown. In the majority of cases the surface activity and the temperature coefficient of activity were nearly the same.

A new method of comparing surface activities of preparations has been devised, depending on behaviour of copper on alternate oxidation and reduction. Such a comparison eliminates errors due to varying conditions of experiment with different preparations.

The cause of catalytic action is considered to be due to fixing groups of atoms in such a state of strain that strong specific external fields are maintained. Results are in agreement with theories of Pease, Taylor, and the author.

The Kinetic Theory of Surface Films. Part II., by R. K. SCHOFIELD AND A. K. RIDEAL. Communicated by Sir William Hardy, Sec., R.S.

In Part I. evidence was obtained, in the case of dilute aqueous solutions of the fatty acids C_1 C_6, in support of Traube's theory that the lowering, F, of the surface-tension of the water is due to an otward kinetic force, exerted over the surface by the molecules comprising the Gibb's excess. Evidence was also obtained in support of Langmuir's view that the surface excess is present as a unimolecular orientated film, but it was shown that these films do not behave like *perfect* gases in two dimensions, as Langmuir supposed. The ratio FA/RT (where A $1/\Gamma$ is the area occupied by a gram molecule of fatty acid in the film) is not unity, but varies with F in a manner completely analogous to the variation of pv/RT with p for *real* gases.

In this communication FA/RT F curves for surface films of the sparingly soluble fatty acids C_8, C_{10} and C_{12} on dilute HCl have been constructed from the surface tension-concentration data of Frumkin. Those for C_8 and C_{10} closely resemble the pv/RT p curves for gases at successively lower temperatures than those to while the lims of the more soluble acids C_4 C_6 were shown (in Part I) to be analogous. That for C_{12} is essentially similar to the FA/RT F curve derived from Adam's F A curve for the expanded film of the insoluble acid C_{11}, and both these films seem to resemble fluids just below their critical temperatures ,that for C_{12} showing a surface-vapour-pressure of a little over 0.2 dynes/cm.

At high-surface pressures the curves are straight, and thus (like those for the lower acids) conform to the two-dimensional Amagat equation $F(A \quad B) = xRT$.

At low-surface pressures the curves, though essentially similar, do not correspond exactly with those of fluids. This is attributed partly to the molecules in the film having two distinct parts with different cohesions, and partly to the elongated shape of the molecules, which become inclined to the plane of the interface when in the act of separating from one another, thus causing the critical area to increase with the length of the hydrocarbon chain.

An Investigation of the Air-Flow Pattern in the Wake of an Aerofoil of Finite Span, by A. Fage and L. G. F. Simmons. Communicated by Prof. L. Bairstow, F.R.S.

The present paper gives an account of some experiments conducted with the object of determining the distribution of velocity in the wake of an aerofoil of finite span. The work of earlier experimenters shows the existence of a longtitudinal vortex system extending across the span from tip to tip; and the results of the velocity measurements over four transverse planes, three behind and one forward of the aerofoil, here given, provide further information on this subject.

An analysis of the results shows that the vorticity is distributed over an area forming a band roughly parallel to the plane and ending in regions approximately opposite the tips, where the intensity is high. Further behind the aerofoil, the band disappears from the central part, and at about 18 chords away, the vortex system resolves itself into two localised areas. Integration over transverse planes 0.57 and 2.0 chords behind the aerofoil shows that the total strength of vorticity leaving a semi-span of the aerofoil is equal to the circulation around the median section; and further, that the distribution of vorticity in these planes is closely connected with the distribution of lift along the span. At 18 chords behind, it was found that the total strength of the vorticity is about 82 per cent. of that measured at 0.57 chords behind.

In front of the aerofoil, and beyond each wing tip, the flow is shown to be irrotational. Over each of the planes of exploration behind the aerofoil, the velocity is sensibly uniform, and this allows the flow pattern to be represented, in the conventional manner, by contoure of the streamline function ψ.

THE CHEMICAL SOCIETY.

On the Budde Effect in Bromine. Part I. The Photo-active Constituent in Wet Bromine. Part II. The Kinetics of the Reaction and the Light Absorption of Wet and Dry Bromine, by B. Lewis and E. K. Rideal.

The Budde effect in bromine is shown to be proportional to both the partial pressure of bromine and water vapour pressures, and is probably due to a photoactive bromine hydrate, Br_2,H_2O. This is strongly adsorbed by glass surfaces and the relationship between the concentration in the bulk and surface phases can be expressed in the form of an adsorption isotherm. The hydrate may be displaced from glass surfaces by water. The Budde effect is not produced by illumination of moist bromine with light or wave length longer than $\lambda = 5800$ A.

The heat of formation of bromine hydrate is found to be 1090 calories comparable to the heat of solution of liquid bromine in water, whilst the equilibrium constant for the dissociation of bromine hydrate at 313° K is of the order of 3.10×10^9. The adsorption curves of wet and dry bromine have been compared, and it is found that absorption commences at $\lambda = 6100$ A for the wet and $\lambda = 5700$ A for the dry gas; this corresponds with a lowering of the critical energy increment of excitation of 3100 calories. When corrected for the absorption and probably flourescent of dry bromine, it is found that the Stark-Einstein law of photo-equivalence is obeyed, a maximum of 1.35 quanta per molecule being obtained.

The Influence of Carbon Rings on the Velocity of Reactions involving their Side-Chains. Part I. The Hydrolysis of Cylic and Open-Chain Malonic Esters, by R. Gane and C. K. Ingold.

Previous experiments, mainly based on ring formation, have shown that the angle between two of the valencies of a carbon atom may be altered by structural conditions relating to the other two.

The Density of Boric Oxide Glass and the Suspected Variation in the Atomic Weight of Boron, by H. V. A. Briscoe, P. L. Robinson, and G. E. Stephenson.

Previous work afforded evidence of an appreciable variation in the atomic weight of samples of boron derived from Asia Minor, Tuscany, and California, respectively. Preparations of pure boric oxide glass have now been made from the mineral sources formerly used and from three other minerals from Chile, the Argentine, and Peru. A flotation method has been developed for the precise determination of the absolute densities of solids and capable of giving still greater precision in the comparison of those densities. This method has been applied to the samples of boric oxide.

The results confirm the relative values of the atomic weight previously found for the

first three samples, and give evidence of further variation in the atomic weight in the samples from South America.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology was held in the Coal, Gas and Fuel Industries Department, The University, Leeds, on Wednesday, November 18, 1925, Mr. F. F. Clark, Vice-President, in the Chair.

Four papers were presented:

Notes on Some Old Yorkshire Glasshouses, by WILFRED R. BARKER.

The author's investigations supplemented those of Mr. Joseph Kenworthy and Mr. Francis Buckley. The glasshouses to which particular attention was given were (1) the glasshouse at Gawber, near Silkstone, which was probably one of the factories mentioned by John Houghton as in operation in 1696; (2) the Worsborough Dale glasshouse, the forerunner of the present firm of Messrs. Wood Bros. & Co., Ltd., Barnsley ;(3) the glasshouse at Rothwell Haigh. Where possible, the sites and remains of these old glasshouses had been visited and examined. The paper was illustrated by numerous photographs.

Some Properties of Sillimanite Bricks and Kaolin-Sillimanite Mixtures, by H. S. HOULDSWORTH, M.Sc.

The addition of sillimanite to fireclay or kaolin decreased the drying and firing shrinkages and increased the porosity as well as the refractoriness of the mixtures containing fireclay. Kaolin was more resistant to the solvent action of a soda-lime glass than were Kaolin-sillimanite mixtures containing less than 60 per cent. of sillimanite. The best results were obtained with test pieces made from a mixture of 66⅔ per cent. of sillimanite and 33⅓ per cent kaolin. The reversible thermal expansion of kaolin-sillimanite mixtures was regular and did not vary appreciably with variations in the percentage of sillimanite present. Some tests on commercial sillimanite bricks were also discussed.

Some Experiments with Sillimanite Pots for Glass Melting, by A. COUSEN, M.Sc., S. ENGLISH, D.Sc., AND PROFESSOR W. E. S. TURNER, D.Sc.

From the point of view of the glass manufacturer the question of resistance to corrosion by glass was generally regarded by the glass manufacturer as more important than any other. Experiments were made in which glass batch was melted in pots under specified conditions, and determinations of the alumina and ferric oxide in the glass were used as a measure of the extensiveness of corrosion. The experiments were carried out on two scales (1), with small pots holding about a pound of glass; and (2) with pots holding about 30 pounds of glass; and tested under continuous running conditions.

In the case of small pots, two series of glasses were employed, namely a soda lime silica glass, and a potash lead oxide-silica glass, both of compositions similar to those widely employed in commerce. With the former series, the main conclusion to be drawn was that the glass melted in sillimanite pots contained distinctly less iron oxide than when melted in ordinary fireclay pots. For the potash lead oxide glasses, the results were similar to those for the soda-lime glasses, the best results being obtained with fine sillimanite, or mixtures containing a preponderance of fine sillimanite. Here, also, the colour of the glasses melted in sillimanite pots was not so marked as when melted in fireclay pots.

The results obtained with the small pots were sufficiently assuring to warrant the preparation of larger pots. Thirty per cent Ball clay with 70 per cent sillimanite was adopted as the standard mixture. The sillimanite mixtures did not work up so easily as ordinary clay mixtures. Shrinkage from the drying state was very small; in fact, almost negligible, even after firing at a temperature of 1,500° C., in the interior of the top of the pot. It was found that a pot could have its temperature reduced at the week-end to 600° C., and be raised again on the Monday to melting value without appreciable harm. A number of meltings of glasses of various kinds were made; 24 meltings in one pot and 20 in another. The general results confirmed those carried out on the smaller scale, the iron oxide content of the glasses being considerably lower than would be expected from fireclay pots.

A Note on the Cause of Shot-Holing in Glasshouse Pots, by PERCIVAL MARSON.

An investigation into the cause for a series of pots failing early in their life owing to shot holes forming in the lower angle at the bottom of the pots. The hole, no more than three-quarters of an inch in diameter,

took a course diagonally downwards through the very thickest portion of the pot, whilst the remainder of the pot was quite sound. It was eventually found that the batch of clay used for making these pots had been made too soon after wetting up. The plasticity of the clay not being fully developed, the layers of clay, even under the best efforts of the pot maker, failed to unite under the usual pressure of his hand, and this left boundaries, along which glass might subsequently find its way.

Owing to lack of time, two other papers on the agenda were taken as read, namely,

Note on a Design for a Glass Pot-Board, by FRANCIS WINKS, M.Sc., Tech.

The Design of Tank Furnaces: A Criticism and Some Suggestions, by H. W. HOWES, M.Sc. Tech.

SOCIETY OF PUBLIC ANALYSTS

AND OTHER ANALYTICAL CHEMISTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, 4 November, 1925. Mr. S. F. Burford, Vice-President, was in the chair.

Certificates were read for the first time in favour of Messrs. John Douglas Barrett, B.Sc., A.I.C.; Arthur Frank Lerrigo, B.Sc., F.I.C.; Oscar Adolf Mendelsohn, B.Sc., Harold Edward Monk, B.Sc., A,I.C., and Eric Voelcker, A.R.C.S.

Certificates were read for the second time in favour of Messrs. Alexander Bruce, B.Sc., F.I.C.; Felix John Theodore Grigg, M.Sc., A.I.C.; Sydney George Clarke, B.Sc., A.I.C.; John Hanley, F.I.C., Arthur John Jones, A.I.C.; Henry William Lawrence, F.I.C.; Fred Mattingley, B.Sc., A.I.C.; Bartle Frere Sawbridge, M.A., F.I.C.; Harold Jacob Stern, Ph.D., B.Sc., A.I.C.; and Major Clive Newcomb, M.D., F.I.C.

The following was elected Member of the Society Mr. Theodore Rendle.

The following papers were read, abstracts of which we publish:

The Determination of Palm Kernel Oil and Butter in Margarine, by G. D. ELSDON, B.Sc., F.I.C., AND PERCY SMITH, B.Sc.

The authors have determined the Reichert, Polenske and Kirschner values of a series of mixtures of palm kernel oil and butter fat in mixtures of other oils and fats in continuation of their previous work on this subject (*Analyst*, 1925, L., 53). Their results are given in a series of tables and compared with the previous results of Bolton, Revis and Richmond. It has been observed that the differences between the calculated and observed values for these figures are very much less in the case of palm kernel oil than in the case of coconut oil, and it is also suggested that the relationship between the Reichert and Polenske value of a given mixture may assist in deciding on the relative proportion of palm kernel oil and coconut oil present.

The Determination of Alcohol and Ethyl Chloride in Chloroform, by CLIVE NEWCOMB, M.D., F.I.C.

Methods have been devised for determining alcohol and ethyl chloride in anæsthetic chloroform and of removing them, so that the degree of purity of the residual chloroform can be ascertained from its physical constants. Alcohol is removed by washing the chloroform with water in a special apparatus, and by determing the density of the chloroform before and after the washing, measure of the amount of alcohol is obtained, whilst the difference between the density of the washed chloroform and that of pure chloroform affords a measure of the potassium hydroxide solution under specified conditions the ethyl chloride is removed, and if the residual washed chloroform has the right density for the pure substance, it is unlikely that other possible impurities are present. Experiments are described showing the influence of the washing on the various substances in chloroform, and the effect of water, alcohol, ethyl chloride and other substances on the density of chloroform.

The Volumetric Determination of Soluble Sulphates by means of Barium Chloride and Potassium Stearate, by H. ATKINSON, B.A., A.I.C.

Sulphates in fairly dilute solution can be determined by precipitating them with excess of standard barium chloride solution, and titrating this excess with standard potassium stearate solution, the end point being shown by B.D.H. universal indicator. In volumetric titrations, the end point is reached before the theoretical amount of barium chloride has been added, and this discrepancy varies with varying concentration, but is constant for equal concentrations, so that corrections, obtained by comparison with standard sulphate solution, can be applied. Metals

forming insoluble stearates (*e.g.*, aluminium, zinc, calcium, magnesium), are removed by precipitation with the potassium stearate solution prior to the titration of the sulphate. The limit of error in the method is of the order of 0.05 c.c. of a 0.1 *N* solution.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting on November 18, 1925, Dr. J. W. Evans, C.B.E., F.R.S., President, presiding, the following papers were read:

A Revision of the Orbitoides of Christmas Island (Indian Ocean), by WINIFRED LAURENCE FALKINER NUTTALL, D.F.C., M.A., F.G.S.

The British Museum Monograph of 1900 included a paper by Prof. T. Rupert Jones and M. F. Chapman on the Tertiary foraminiferal limestones. These authors described the smaller foraminifera as well as the larger Orbitoides, the latter group being little known at the time when their work was undertaken.

The author re-examined the Orbitoides, primarily in order to ascertain whether with their aid new light could be thrown on the age of the beds. In so doing he found that the original descriptions of the species were often inadequate, and details were omitted which of recent years have become of prime importance in their recognition. He has, therefore, been led to make a complete revision of Jones and Chapman's species. He has identified six species of *Lepidocyclina*, one species of *Miogypsina*, and one of *Spiroclypeus*. The Lepidocyclines are characterised by possessing no pillars in the lateral chamber-layer, and the two megalospheric forms have the embracing type of primordial chamber restricted to the subgenus *Eulepidina*. These species are found in Limestone C, as defined in the Christmas Island Monograph, which formation is classified as Lower Miocene. The author has found a *Discocyclina* in Limestone B as well as in A, no Orbitoides having been hitherto discovered in the former. This indicates that these beds are both of Eocene age.

A discussion followed.

The Volcanic Rocks of Christmas Island (Indian Ocean), by WALTER CAMPBELL SMITH, M.C., M.A., Sec. G.S.; with chemical analyses by Edgar Donald Mountain, B.A.

This paper is the result of the examination of rocks collected by the late Dr. C. W. Andrews in 1897-89, and briefly described by him in "A Monograph of Christmas Island," in 1900.

There were two periods of vulcanicity in Christmas Island. The older lavas are overlain by a limestone now proved by Mr. W. L. F. Nuttall to be Eocene. This lower series includes alkalitrachytes, tractybasalts (trachydolerite), olivine-basalts, nepheline-basanites, limburgitic basalts, and limburgites. The upper lavas include limburgitis basalts and olivine-basalts similar to those in the lower series, and also limburgites and palagonits-tuffs. These upper lavas are overlain by a limestone with *Orbitoides* referred by Mr .Nuttall to the "older Miocene" of Rutten. Chemical analyses have been made of seven of the volcanic rocks. All the lavas, both Eocene and Miocene, are considered to belong to a single petrological series. Comparisons made with analyses of other lavas show that the rocks resemble very closely certain Tertiary and Permo-Carboniferous lavas from New South Wales. On the other hand, no analyses of rocks from Java and Sumatra are found to compare with those of the Christmas Island Rocks.

NEW LABORATORIES OPENED AT ST. ANDREW'S UNIVERSITY.

On the fourth inst., Sir William Bragg, opened new research laboratories at St. Andrew's University, and in the course of his address, said that it was only in recent times that we had really grasped the meaning of the atomicity of electricity. It used to be thought that electricity was a continuous quantity. It was known now that negative electricity was done up in parcels, all exactly alike, and that positive electricity was also atomic in character. From this conception sprang all our use of the electric discharge in the vacuum tube and the phenomena of X-ray, of the wireless valve, and innumerable advances in pure science. Later still was the conception of the atomic division of energy, and the so-called quantum theory, which had proved so fruitful as a guide to research. The realisation of the atomic theory of matter leads ,on the one hand, to the still more minute quantities with which radio activity concerned itself, and, on the other, to the conception of molecules, the small com

panies of atoms more or les spermanent in character which were the subject of the chemist's work.

NOTICES OF BOOKS.

Practical Physical and Colloid Chemistry for Students of Medicine and Biology, by LEONORD MICHAELIS. X + 196. Price, 7s. 6d. net. W. Heffer and Sons, Ltd., Cambridge.

The present issue is an authorised translation from the second German edition by F. R. Parsons, B.Sc., M.A., Cambridge University, and obviously the author was fortunate in having his work translated by such a sympathetic fellow-author. The plan of the work, a series of practical exercises, with brief but lucid expanations, is calculated to meet the needs and wishes of the students for whom it was written.

FORTHCOMING EVENTS.

THE OPTICAL SOCIETY.

The next meeting of the Society will be held at The Imperial College of Science, Imperial Institute Road, South Kensington, at 7.30 p.m., on Thursday, December 10, 1925. Several papers will be presented.

SIR JOHN CASS TECHNICAL INSTITUTE.

(Jewry Street, Aldgate, London.)

Annual Distribution of Prizes and Certificates, December 15, at 7.45 p.m.

Statement on the work of the Session 1924-25, by the Chairman, the Rev. J. F. Marr, M.A., Chairman of the Governing Body. Sir Thomas Kirke Rose, D.Sc., A.R.S.M., Past President of the Institution of Mining and Metallurgy, distributes the awards and delivers an address on "Metallurgy and Minting," in the Lecture Theatre. Exhibition of work by Students of the Art Department in the Art Rooms on the ground floor. Exhibition of Apparatus and Students' work in the basement and on the first, second and third floors.

PHYSICAL SOCIETY OF LONDON.

December 11, at 5 p.m., at the Imperial College of Science. Various papers will be read.

JUNIOR SOCIETY OF ENGINEERS.

December 11, at 7.30 p.m., at the Rooms of the Royal Society of Arts, John Street, Adelphi.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology will be held in the Chemistry Lecture Theatre, University College, Gower Street, London, on Wednesday, December 16, 1925, at 2.30 p.m.

The following papers will be communicated:

"The Composition of Glass Suitable for Use in Automatic Machines," by Professor W. E. S. Turner, D.Sc.

"The Relationship between Chemical Composition and the Durability of Glass," by Violet Dimbleby, M.Sc., and Professor W. E. S. Turner, D.Sc.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

28,488. Brenek, H. - Process for transforming barium and strontium sulphates. November 11th.

29,228. - Distilleries des Deux-Sevres.—Dehydration of ethylic alcohol. November 19th.

28,882,—Du Pont de Nemours & Co., E.I. Production of benzoic acid. November 16th.

28,946. Kalle & Co., Akt.-Ges.—Producduction of nitriles of the benzanthrone series. November 17th.

29,096. -Lambert, A.—Manufacture of alkali salts. November 18th.

Specifications Published.

242,817.—Schwarz, F.—Process of purifying mineral-oil products and the like.

242,828.—Knoll & Co., Chemische Fabrik. Method of manufacturing medic inal jujubes.

242,383. Mills, L. D., & Crowe, T. B. Process of and apparatus for precipitating and filtering.

229,884.- Rhenania Verein Chemischer Fabriken Akt-Ges. Manufacture of chlorine.

240,514.—Dyeing cellulose esters.—Bad-

Abstract Published.

ische Anilin and Soda Fabrik, Ludwigshafen-on-Rhine, Germany.

In the dyeing or printing of cellulose esters, and particularly of cellulose acetate silk, the ester is treated previously or simultaneously with a solution of an acid ester of a mineral oxygen acid, such as sulphuric, phosphoric or boric acid, or with a solution of a salt such as acid ester. In examples cellulose acetate silk is dyed by treatment first in a warm bath of potassium ethyl sulphate and then in a bath of Diamond Green B; by treatment first with sodium dicresyl phosphate and subsequent dyeing with Methyl Violet 2B, with or without waste sulphite cellulose liquor, or Azoflavine RS, or with a hydrosulphite vat of Indanthrene Blue GCD containing, if required, a protective colloid; and by treatment in a bath containing both sodium dicresyl phosphate and the dyestuff Auramine II. A further example shows the printing of acetate silk with a paste comprising Euchrysine 3R, dicresyl phosphate, acetine and gum.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

VASSOLA.

463,300. Chemical Substances prepared for use in Medicine and Pharmacy. --Wigglesworth, Ltd., Peel Mills, Church Street, Westhoughton, Lancashire. November 25th, 1925.

463,158.—Full representation of two male figures for Chemical Substances prepared for use in Medicine and Pharmacy.--Wigglesworth, Ltd., Peel Mills, Church Street, West houghton, Lancashire. November 25th, 1925.

450,560. Label device bearing word SIEROCASALI, for a medicinal remedy for human use in the treatment of Arteriosclerosis, Anaemia Decline, Infectious Diseases and Metabolic Disturbances. Societa Preparati Casali ,67, Via Lucrezia Caro, Rome, Italy. November 25th, 1925.

MOTYL.

462,663. Chemical substances used in manufactures, photography or philosophical research and anti-corrosives. Badische Anilin & Soda Fabrik, Friesenheimerstrasse, Ludwigshafen-on-Rhine, Germany. November 18th ,1925.

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THE PRODUCTION OF SULPHURIC ACID BY ELECTROLYSIS.

By ROBERT SAXON, B.Sc. (Vict.)

Solutions of copper, iron, or aluminium sulphates are acid, but not sufficiently so to affect methyl orange. This is probably due to the fact that water ionises and hydrolyses these, thus producing sulphuric acid.

$$Al_2(SO_4)_3/6HOH \qquad 2Al(OH)_3/3H_2SO_4$$
$$CuSO_4/2HOH \qquad CU(OH)_2/H_2SO_4$$

In this notation, introduced to save spece, the usual plus sign is replaced by / and the sign means " gives at ordinary temperature."

The addition of magnesium to a solution of ammonia alum, or copper sulphate causes a slight evolution of hydrogen, undoubtedly from the sulphuric acid. Moreover with a saturated solution the discharge of gas is less brisk than with one more dilute. Too much water has of course the opposite effect. A 0.001 per cent. solution of sulphuric acid saturated with ammonia alum gives off a faint stream of hydrogen with magnesium. This stream becomes a shower as water is added.

This evolution of hydrogen is much more rapid under the influence of electrolysis. It is still further accelerated by the addition of an equimolar amount of copper sulphate, so much so that it forms a potential field of research with regard to the making of sulphuric acid. A solution of an equimolar mixture of copper sulphate and ammonia alum coloured brown by methyl orange, turns pink round the anode immediately the current is switched on. This becomes stronger as the action proceeds, then strawberry, violet, blue violet, pale blue, and later, practically colourless. At this last stage there is no copper sulphate in solution. The methyl orange is either precipitated or bleached.

Addition of methyl orange restores the pink colour, which deepens, as we look, from the bottom upwards. The strength of the sulphuric acid may be ascertained by noting the volume of hydrogen given off by a given volume of liquid, using magnesium or sodium, in the latter case allowing for the water. The amount of sulphuric acid will be found to correspond with the copper sulphate used within the range of experimental error. The reaction may be symbolised thus :

$$Cu \quad ' \qquad CuSO_4H_2O \quad - \quad '' — O$$

from which we get sulphuric acid by subtracting the de-ionised Cu and O from the ionised central group. Water is also split up into its elements.

This notation represents the cathode, or negative pole, by the sign ' and the anode " and copper or oxygen ionised touching such is de ionised and passes out as copper or oxygen ordinary.

The use of an easily deposited metal assists greatly in the production of sulphuric acid in the electrolyte for the follow- reasons :--

1 The deposited metal juts out from the cathode, enlarging it.

2 The metal, being in a fine state of division, gives great surface for the discharge of gas, which is the factor responsible for the other changes.

3 It forms a compound cathode-anode between the regular electrodes everywhere where there is not actual connection with the cathode.

As electrolysis proceeds the alum is split up, ammonia given off which of course forms ammonium sulphate again and also aluminium hydrate. Addition of fresh copper sulphate, however, results in vigorous action, becoming still more so as copper is deposited. In seven hours, with ordinary lighting current, it is possible to obtain a 17% solution of acid, in addition to an abundant crop of copper.

As electrolysis removes water only, a stronger current would assist in concentrating the acid by this means, and also by virtus of the heat generated by the passage of greater current density.

THE REACTION BETWEEN BISMUTH TRISULPHIDE AND HYDROCHLORIC ACID.

By S. RAMACHANDRAN.

It has already been reported by me in previous papers on this subject (1) that bismuth trisulphide could not be precipitated from a solution of a bismuth salt in "concentrated" hydrochloric acid; (2) that bismuth trisulphide is easily soluble in concentrated hydrochloric acid in the cold with distinct liberation of sulphuretted hydrogen; (3) that bismuth trisulphide is quickly and completely acted upon by boiling hydrochloric acid of concentration 1 : 5Aq.; and (4) that the evolution of sulphuretted hydrogen from bismuth trisulphide by the action of acid begins at increasing temperatures with increasing dilution of the acid.

The results obtained from a further qualitative study of this reaction are given in this paper.

EXPERIMENTAL.

(1) About 10 c.c. of hydrochloric acid of the approximate concentrations noted below were added to little quantities of the well powdered pure product placed in several test-tubes. The latter were heated uniformly and carefully by placing them in a water-bath, the temperature of which could be easily controlled. The temperature at which the evolution of hydrogen sulphide commenced was noted in each case and it was found that it increased with increasing dilution, although powdering the substance produces a marked effect in that with an acid of a certain concentration hydrogen sulphide begins to be evolved at a lower temperature than when the substance is not powdered.

1 : 5 Aq.	About 40 deg. C.
1 : 10Aq.	,, 55 ,,
1 : 16Aq.	,, 70 ,,

(2) To further prove the fact that hydrochloric acid of all concentrations (at least up to the ones now under investigation) act upon bismuth trisulphide even at our laboratory temperature (about 29 deg. C.), small quantities of the substance were placed in several test tubes and digested with 5.c.c. of acid of differing concentrations (above 1 : 5Aq. up to 1 : 16 Aq.) for not more than half an hour each the temperature being kept constant by immersing the tubes in a water bath kept at 29 deg. C. The resultant turbid liquid was filtered off in each case, boiled, and cooled. Through the filtrate a stream of sulphuretted hydrogen was passed, when it was found that, in each case, there was a distinct precipitation of brownish-black bismuth trisulphide.

(3) Small quantities of the well-powdered substance were again digested in the cold for about half an hour with 10 c.c. of hydrochloric acid of different concentrations and the mixture filtered off. On merely diluting the clear filtrates, no precipitation was observed.

(4) Pure bismuth trisulphide was precipitated from a slightly acid solution of bismuth trichloride and the precipitate kept in contact with the liquid from which it was precipitated for about 48 hours. It was afterwards filtered off, purified, and dried. There was found to be no change in the behaviour of the substance towards hydrochloric acid showing thereby that the nature of the product is not altered by keeping it in contact with the medium from which it was precipitated.

Further experiments are being conducted on this subject.

Contribution to the "Chemical News" from :

The Chemical Laboratory,
Ceded Districts College,
9 November, 1925.

ELECTROLYTIC REDUCTION OF OXIMES, III. BENZILDIOXIME.

By MASAYOSHI ISHIBASHI.

With the object of tracing the cathodic reactions which benzildioxime undergoes under various conditions, it was electrolysed both in the acid and in the alkaline solutions, using lead at the cathode. As we expected, reduction and hydrolysis take place side by side and many reduction-products were produced together. The ultimate reduction-product was diaminodiphenylethane which was obtained both in racemic and in meso-form. This fact is of interest when we compare it with purely chemical reduction which is reported to have produced the racemic form only, Other reduction-products such as diphenyloxyethlyamine (normal and iso), tetraphenylaldine, benzoinpinacone, desoxybenzoinpinacone, toluylenehydrate (iso) and hydrobenzoin (normal and iso) are all derived from the hydrolysed dioxime by reduction. Of these substances, tetraphenyl-

aldine may indeed be regarded as a reduction-product directly formed from the dioxime as Polonowska assumes. But the author considers it more likely to be produced from benzilmonoxime, and from this view point he put forward an assumption about the mechanism of the reaction which well accounts for the aldine formation, and establishes an analogy between the reduction of the carbonyl group on the one hand, and the oxime group on the other. It is to be noted here that the toluylenehydrate obtained by the reduction is not identical with that hitherto recorded in chemical literature. It is probably a new isomer.

(Memoirs, College of Chemistry, Tokio University.)

CLAY.

By JEFFERSON MIDDLETON.

(U.S.A. Geographical Survey.)

Clay available for the manufacture of clay products is widely distributed in the United States, and there are clay-working plants in every State in the Union. The following figures represent chiefly clay that is mined and sold as clay. The quantity thus sold is small compared with the total output and includes mainly clay used for making high-grade pottery and tile and refractory products. The values given for domestic production are f.o.b. at the mines; for imports, at the principal markets of the countries from which the clay is exported; for exports, at the ports of shipment.

The general prosperity of 1923 was shared by the clay-mining industry, which made the largest sales of clay yet recorded. The output in 1923 was greater by 320,816 tons, or 10 per cent., than that in 1917, the year of largest output prior to 1923. The value of the clay sold in 1923, however—$87,750—was 0.8 per cent. less than in 1917, because the prices were lower. The increase in quantity over the output of 1922 was 780,960 tons, or 30 per cent., and the increase in value was $,858,899, or 34 per cent. Every kind of clay named in this report except stoneware clay, increased in quantity, and every kind increased in value. The decrease in stoneware clay compared with 1922 was small—5,477 tons, or 6 per cent. Ohio, the largest producer of stoneware clay in 1922, showed the greatest decrease, owing to a strike in the great stoneware-pottery region of that State, in Muskingum and Perry counties. Slip clay showed the largest proportional increases—110 per cent. in quantity and 125 per cent. in value. Fire clay, which constitutes the largest volume of clay sold, forming 67 per cent. of the total in 1923, showed the largest increases—618,943 tons, or 37 per cent., and $1,982,418, or 42 per cent. The increasing use of domestic kaolin and the fact that imports of foreign kaolin are increasing but little should be most gratifying to the miners and users of this material, as they lead to the hope that eventually this country will become independent of foreign supplies of kaolin. Ball clay, which is largely used in combination with kaolin in the manufacture of high-grade ceramic wares, increased considerably in quantity and value. It reached its highest value in 1923 -$620,078, which was 41 per cent. greater than in 1922 and 5 per cent. greater than in 1918, the year of greatest value prior to 1923. The quantity of ball clay in 1923 was 10,338 tons, or 10 per cent. less than in 1917, the year of largest production, but 20,276 tons, or 26 per cent., more than in 1922. This is another kind of clay for which the country has been largely dependent on foreign supplies, but a study of the comparative value of the American and English ball clays by the Bureau of Standards shows that in some respects the American clays are superior and in others equal to the English clays and only require more careful manipulation to make them acceptable substitutes.

Imports of clay in 1923 increased 30,708 short tons, or 9 per cent., in quantity, and $260,848, or 8 per cent., in value, compared with 1922. Imports of every kind of clay reported increased in quantity and value except wrought clay, usually the smallest item among imported clays. The unwrought clays, which probably include ball clay, showed the largest increase—24,755 tons, or 61 per cent., in quantity, and $154,226, or 47 per cent., in value. Exports of clay increased in even greater proportion than production. The quantity of clay exported increased 37,219 tons, or 78 per cent., and the value increased $105,295, or 45 per cent., compared with 1922. Fire clay, which constituted 59 per cent., of the quantity and 48 per cent. of the value of clay exported in 1923, increased 25,664 tons, or 105 per cent., and $184,011, or 79 per cent., compared with 1922. Notwithstanding the large increases in exports, compared with 1922, the quantity was 29 per cent., and the value 46 per cent. less than in 1920, the year of maximum quantity and value.

Trade and General Notes.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

Application for Licences in November, 1925.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1925, made during November, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 682, of which 579 were from merchants or importers. To these should be added 84 cases outstanding on the 31st October, making a total for the month of 716. These were dealt with as follows:

Granted 597 (of which 550 were dealt with within 7 days of receipt).

Referred to British Makers of similar products 76 (of which 58 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available 5 (all dealt with within 2 days or receipt).

Outstanding on 30th November, 1925 38.

Of the total of 716 applications received, 608, or 85 per cent., were dealt with within 7 days of receipt.

CANADIAN MINING NOTES.

Discovery of Lithia Ore in Canada.

Among the many interesting announcements made at the annual meeting of the Canadian Institute of Mining and Metallurgy recently held at Winnipeg, was one by Mr. F. B. Evans reporting the discovery and development of what is said to be the richest field of lithia ore on the American continent, and one of only four or five such fields in the world.

The ore body lies at Pointe du Bois, north of Winnipeg, and is being developed by British capital. It is stated that 10,000 tons of ore, valued at $1,000,000, have been revealed up to the present by stripping operations.

Alberta's Petroleum Situation.

Dr. John Allan, Professor of Geology at Alberta, in a comprehensive survey of the petroleum situation in Alberta, at the annual meeting of the Canadian Institute of non-commercial exhibits by Fellows of of Mining and Metallurgy, give the following survey:

In the Alberta area, 285,000 square miles of which approximately 80,000 square miles has petroleum possibilities wells drilled to 1925 numbered about 96, wells completed about 15, and wells being drilled in August ,1925, 15.

The oil production in Alberta from 1915 to 1924 was only 60,000 barrels, but the present production from Royalite No. 1, Turner Valley, is about 500 barrels per day, very high gravity gasoline, 78 degrees Beaume, and the possible production from British Pertoleum's No. 3B, Wainwright, about 100 barrels per day.

Re-Opening Canada's Oldest Lead Mine.

The Wright Lead Mine, 250 years of age, the oldest metal mine in Canada, is being re-opened, owing to the strong position of the lead market.

Utilising Waste Sulphur.

The Mond Nickel Company has just completed at Coniston, Ontario, a new sulphuric acid plant, which is now in operation, marking the first successful effort to save the sulphur hitherto going to waste in the reduction of the nickel ore at the company's smelter there. All strengths of acid will be produced, and, owing to the low cost a twhich it can be produced, it is expected that th econsumption of the product will be stimulated in Canada.

SIXTEENTH ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY OF LONDON AND THE OPTICAL SOCIETY.

This Exhibition, which is to be held on Tuesday, Wednesday and Thursday, January 5, 6 and 7, 1926, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, will be open in the afternoon (from 3 to 6 p.m.), and in the evening (from 7 to 10 p.m.).

Mr. J .E. Barnard, F.R.S., will give a lecture on "The Search for Ultra-Microscopic Organisms," at 8 p.m. ,on January 5; Professor A. F. C. Pollard, A.R.C.S., A.M.I.E.E., will give a lecture on "The Mechanical Design of Instruments," at 8 p.m., on January 6; and Major W. S. Tucker, D.Sc., will give a lecture on "Electrical Listening," at 8 p.m. on January 7. These lectures will be illustrated by lantern slides and experiments.

Some 70 firms will exhibit scientific apparatus, and in addition there will be a group the Societies and others, including demonstrations of famous historical experiments in physics, recent physical research and effective lecture experiments.

It has been decided to open the Exhibition to the general public without tickets on the third day, January 7. On January 5 and 6, tickets of admission wil lbe required.

We understand that invitations relating to January 5 and 6 have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Radio Society of Great Britain, the Rontgen Society, the Faraday Society and other scientific societies. Members of such societies should apply for tickets to the secretary of the society to which they belong. Others interested should apply direct to Professor A. O. Rankine, Imperial College of Science and Technology, South Kensington, S.W.7.

IN PARLIAMENT.

HEAVY CHEMICAL TRADE (ACCIDENTS).

On December 10, Mr. J. Baker asked the Home Secretary whether, seeing that in the Report of the Chief Inspector of Factories for 1924 it is stated that only three out of 5,000 accidents in the heavy chemical trade were due to a breach of the Regulations, it is proposed to introduce further Regulations with a view to reducing the number of accidents in this trade?

Sir W. Joynson-Hicks: The 5,000 accidents reported from all classes of works in the Warrington district. Only 670 of these occurred in the chemical trade. The great majority of these 670 accidents appear to have been due to risks which are incidental to every class of industry, and which, for the most part, are not preventable by Regulations, such as, for example, persons falling, or stepping on or knocking against objects, and so forth. So far as one can see at present, the only hopeful way of dealing with this class of accidents is through the establishment of safety organisations in the individual factories and the development generally of the Safety First movement. Everything possible will be done by the Factory Department to stimulate action in this direction.

VARNISHES OR DOPES (MANUFACTURING CONDITIONS.)

Mr. J. Baker asked the Home Secretary whether, having regard to the great increase in the use of varnishes or dopes composed of celluloid or nitro-cellulose dissolved in acetone, amyl acetate, or similar solvent, he is satisfied that the present Regulations governing ventilation and the absence of naked lights are satisfactory; and, if not, whether it is proposed to introduce Regulations governing factories where the varnishes or dopes are used at an early date?

Sir W. Joynson-Hicks: Very few accidents or dangerous occurrences from the use of these varnishes or dopes have so far been reported, and I am advised that so far as danger to health from inhalation of the fumes is concerned, the existing requirements of the Act have been found adequate. The Chief Inspector is not satisfied as to the position in regard to the risk of fire or explosion, and special inquiries into this point are now in progress.

LEAD POISONING.

Mr. Robinson asked the Home Secretary how many cases of lead poisoning occurred among pasters engaged in the manufacture or repair of electric accumulators in the years 1921, 1922, 1923 and 1924, respectively; and whether any cases have been reported since the new code of Regulations came into force on 1 March, 1925?

Sir W. Joynson-Hicks: There were five such cases reported in 1921, 11in 1922, 44 in 1923, and 42 in 1924. Since the 1 March, there have only been 15 cases among pasters. The new Regulations cannot be expected to have their full effect for a considerable time, but they appear to have already caused a substantial reduction in the number of cases.

We have received Catalog No. 85 of Reagents, issued by the General Chemical Co., New York. There are listed some 950 products by Baker and Adamson. The chemicals are made to high standards of purity, and the analysis of many is given.

CHEMICAL POISONING.

Mr. Robinson asked the Home Secretary how many cases of poisoning by carbon bisulphide, aniline poisoning, and chronic benzene poisoning have been reported since 1 February, 1925; and what special steps are being taken by his Department to diminish the risk of chemical poisoning?

Sir W. Joynson-Hicks: Two cases of carbon bisulphide and 30 cases of anilin poisoning have been reported, but no case of chronic benzene poisoning. Special steps are taken to diminish the risk by following up each case, and generally by the enforcement of the special precautions required by the Chemical Works Regulations of 1922. The whole subject is receiving special attention from the medical inspectors.

ABSTRACTS.

TO DEODORISE WOOL-GREASE.

Insoluble suint can, it is claimed by the inventor, Mr. Gillet, be completely and rapidly deodorised by this method without special plant or labour. The bad odour of wool grease is due to a mercaptan, which can be separated by treating the grease in any kind of vessel, with a sulphide or poly sulphide, sulphur, or sulphur compound, and an alkaline agent. These two substances are added together to the grease maintained in emulsion or not so. The mercaptan liberated becomes soluble in water in presence of an alkali. After separation, the wool grease is washed in form of emulsion and obtained perfectly odourless.

Industrie Chimique, October, 1925.

LUBRICANTS FROM TAR.

The utilisation of low temperature tars for production of lubricating oils has not hitherto been practical as these tars contain a high percentage of phenols which can only be removed at great expense, thus preventing all competition with petroleum. For example, the percentage of phenol in lignite generally exceeds 40%, and to wash 100 quintaux of such oil, 130 to 150 hectolitres of a 9% soda lye are required. The yield of washed oils being an average of 50% there must be 260 to 300 hectolitres of lye and an agitator with a utilisable volume, of 450 to 500 hectolitres, to produce 100 quintaux of washed oil. This example shows what difficulties there are with regard to plant and labour. There is, however, another treatment, consisting of precipitation of the phenols with mineral acids. For application in industry it suffices to utilise residual sulphuric acid from refining oils. The oil is agitated with about 10% of acid diluted to 50%, and the two layers are separated. The heavy oil can be utilised after washing in water, like carbolineum.

Industrie Chimique, October, 1925.

CITRIC ACID.

There are, as is known, certain fungi, such as the *citromycetes*, *mucors*, *aspergillus* and *penicilliums*, which, in certain conditions, produce relatively large quantities of citric acid.

Their slight activity and the long length of time in fermentation are a cause of some infection. These inconveniences have led to the conclusion that good results can only be obtained by working with a semi-solid medium, for example, gelatine or agar-agar.

Particularly suitable varieties can, according to a German inventor, J. Szucs, be cultivated, utilising molasses as the medium of culture. The *aspergillus niger*, for example, generally produces oxalic acid, but different varieties of this species also produce citric acid. It is merely necessary to select the most suitable cultures for production of citric acid according to the known methods of mycological analysis.

By employment of molasses as a nutrient solution, citric acid is obtained in large quantities by fermentation at a relatively low temperature, 20° C. being the most favourable for the *aspergillus*. At higher temperatures, the fungus thrives and also produces a great deal of citric acid, but this acid is oxidised more and more as the temperature rises and is transformed into oxalic acid. On the other hand, when the fungi are cultivated at a high temperature, spores are produced which gradually lose the faculty of producing citric acid in sufficient quantity.

Citric acid formed in flat open vats for fermentation, can be neutralised gradually with alkalies, or terreous alkalies, though this is not absolutely necessary. Barium in form of hydroxide or carbonate is best for this neutralisation because its citrate is more insoluble than that of calcium at low temperatures. Recovery is easy in form of sulphate, which is of commercial value.

Industrie Chimique, October, 1925.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read on December 3, 1925.

Fluid Resistance to Moving Spheres, by R. G. LUNNON. Communicated by Prof. T. H. Havelock, F.R.S.

The paper records a large number of measurements of the times of fall of spheres, differing in size and density, through distances varying from 3 to 588 metres, in coal-mine shafts and other places. The resistance of air is calculated from an analysis of the observed rates of fall, and the way in which resistance depends upon velocity and acceleration for any sphere in linear motion is deduced by combining the results from different spheres. The range of velocity is such that thhe values of the Reynolds number are in the critical region ($10^4 < R < 10^5$), in which the resistance to uniform motion is proportional first to a power higher than the second, and later to a lower power.

It is is found that the effect of acceleration is to accentuate the rapid change in the resistance coefficient ($F/\rho V^2 d^2$), and details of the change are shown graphically for various values of the acceleration. An approximate formula is suggested and applied, and the few previous published records, including those of Sir Isaac Newton, are found to be in harmony with it.

An application of the theory of dimensions suggests that the fluid resistance may depend not only upon velocity and acceleration, but also upon the rate of change of the acceleration. Finally, an example is given of the diminishing of air resistance due to the roughening of the surface of a sphere.

The Fundamental Equations of Quantum Mechanics, by P. A. M. DIRAC. Communicated by R. H. Fowler, F.R.S.

The paper is a development of Heisenberg's work on a new quantum significance of kinematic and mechanical relations.

It is assumed that the equations of motion of a multiply periodic dynamical system can be taken over as they stand into the quantum theory, but that special mathematical operations must be used for interpreting them, which are such that the different solutions of the equations of motion are all interlocked and cannot be considered separately. Any variable x is taken to be represented by harmonic components of the form $x(nm)$ exp. $i\omega\ (nm)t$. where n and m refer to two stationary states or two sets of quantum numbers, and the frequencies $\omega(nm)$ satisfy the relation $\omega(nm) + \omega(nk)$. The product of two variables x and y has the amplitudes of its components determined by the equation $xy(nm) = \Sigma_k x(nk)y(km)$. Multiplication is thus not commutative, but except for this the algebraic laws are the usual ones.

Certain quantum conditions are necessary to complete the solution of the mechanical problem, which may be taken to be $q_r q_s - q_s q_r = 0$; $p_r p_s - p_s p_r = 0$; $q_r p_s - p_s q_r = 0$ when r is not equal to s and $ih/2\pi$ when r equals s, the p's and q's being a set of canonical variables.

It is shown that the energy is the same function of the action variables as on Bohr's theory, and Bohr's relation between the frequencies and energy levels is deduced.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

An All-Electric House, by PROFESSOR S. PARKER SMITH, D.Sc., Member. Paper recently read before the Institution.

The scarcity of precise and detailed information on the several domestic applications of electricity encouraged the author to write a succinct account of the arrangements adopted in a 10-roomed house designed and built in Glasgow for all-electric working. In this house neither coal nor gas is used. The sections dealt with are :—

(1) Layout of house.
(2) Distribution board.
(3) Wiring.
(4) Bells.
(5) Lighting.
(6) Clothes-washing and drying.
(7) Cooking.
(8) Hot water.
(9) Ventilation.
(10) Heating.
(11) Running costs.
(12) Conclusions.

The total cost of 10,584 units used in one year's working was £48 8s. The consumption and costs are analysed for the several services.

In an appendix, the results of a 4-roomed all-electric flat are given. The consumption for one year was 4,656 units, and the total cost of energy was £14 18s.

ADVANTAGES OF AN ALL-ELECTRIC HOUSE.

The manifold advantages of the all-electric house will probably appeal chiefly to people whose habits are not inflexible and to innumerable small households where coal merely means drudgery. As regards cost, with energy not exceeding 1d. or even 1½d. per unit overall, it would seem to be feasible to work large, medium, or small houses electrically, though the cost of installation may remain a difficulty. Fortunately, this matter seems now to be receiving the sympathetic attention of supply undertakings, and it may therefore be not too presumptuous to look forward to a time in the near future when the full advantages of electricity in the home will be available to all. Among the advantages associated with electricity, cleanliness and health may well be emphasised. The absence of coal fires in a house like the one just described may make it possible to dispense with one domestic servant and thereby not only more than repay the total cost of the electrical energy, but also lighten the domestic labour problem. Equally, the improved health of the household and of the community, by eliminating smoke, is an inestimable benefit. Again, the rational mode of distributing and controlling heat is a great boon. Internal decorations seldom need renewal; cut flowers may last a month or even longer. Nuemrous minor luxuries become normal comforts and conveniences.

The Power Losses in Magnetic Sheet Material at High Flux Densities, by C. E. WEBB, B.Sc.(Eng.), Associate Member. (From the National Physical Laboratory.)

From an examination of the results of a number of investigations it is shown that while there is general agreement as to the validity of Steinmetz's expression ηB^x, where x is a constant index, for the hysteresis loss at flux densities up to about 10,000 C.G.S. units, there are considerable divergences between the results of different experimenters at flux densities above that value, particularly in tests on sheet material. Some find Steinmetz's law to apply closely up to the highest flux densities at which tests could be carried out, whilst others record more rapid variations of hysteresis losses with B in the region of B = 10,000-16,000. the extent of the departure from Steinmetz's law also varies considerably, some observers finding a maximum exponent of approximately 2.0 and others obtaining values as high as 3.2.

In the paper a series of tests, both by a.c. and ballistic methods, on a wide range of sheet materials is described. The results of this appear to confirm the increase in the exponent of B in the expression for the hysteresis loss at values of B between 10,000 and 15,000. They also show comparatively little difference between the various specimens of sheet material tested.

The construction of a new Lloyd square for tests at still higher flux densities, and a further, more detailed, series of tests, both a.c. and ballistic, on a representative specimen of each type of material, making use of this square, are then described. These tests were carried up to B 17,000 or 18,000, and, while confirming and extending the previous results of increased exponents of B for values up to 16,000, indicate a rapid decrease in the exponent at the highest values of B employed.

ROYAL INSTITUTION.

The lecture arrangements at the Royal Institution before Easter next year were announced at the general meeting of the Members on December 7.

The Juvenile lectures, the 100th course, will be delivered by Sir William Bragg, on "Old Trades and New Knowledge," commencing on December 29, at 3 o'clock.

On Tuesdays, at 5.15, beginning on January 19, there will be two lectures by Dr. J. A. Crowther, on "X-rays and Living Matter"; two by Dr. E. K. Rideal on "Surface Action"; four by Professor Barcroft on "The Egg"; and two by Dr. C. H. Desch, on "The Growth of Crystals."

On Thursday, Janhary 21, at the same hour, Dr. C. J. Patten will give the first of two lectures on (1) "The Language of Birds, (2) "The Breeding Factor in Birds." These will be followed by three lectures by Dr. J. L. Myres on "Who were the Greeks?"; three by Dr. C. D. Ellis, on "The Atom of Light and the Atom of Electricity"; two by Dr. J. Holland Rose on "The Indecisiveness of Modern Warfare."

On Saturday afternoons, at three o'clock, Mr. Henry Balfour will give two lectures commencing on January 23, on (1) "The Evolution of Currency and Coinage," (2) "The British Coracle, or the Skin Covered Boat and its Affinities."

On succeeding Saturday afternoons there

will be two lectures on "The Nature and History of the Triad and the Perfect Fourth," by Sir Walford Davies, with musical illustrations; two by Dr. George Macdonald on "Roman Britain"; and four by Sir Ernest Rutherford on "The Rare Gases of the Atmosphere and their Importance in Atomic Theory."

The Friday evening meetings will begin on January 22, when Sir William Bragg will deliver a discourse on "The Work of the Davy Faraday Research Laboratory." Succeeding discourses will probably be given by Sir William Hardy, Professor Robert Robinson, the Hon. J. W. Fortescue, Dr. C. Hagberg Wright, Sir J. J. Thomson, Mr. John Tweed, Sir Ernest Rutherford, and other gentlemen.

A general meeting of the Members of the Royal Institution was held on December 7. Sir James Crichton-Browne, treasurer and Vice-President presided.

The special thanks of the Members were returned to Dr. W. Rushton Parker for his donation of £100 towards the improvement of the Library.

Mr. W. G. Bruty, Dr. P. C. Buck, Mr. J. R. Cousins, Mr. J. Scott Duckers, Mr. A. Edmunts, Mr. M. A. Greig, Mr. E. Marsden, Mrs. Murray, Lieut.-Col. B. C. Quill, Mr. A. L. Reckitt, Miss E. M. Stear, Mr. J. A. Stevenson, and Mr. H. B. Gordon Warren were elected Members.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the meeting held on Friday, November 27, 1925, at the Imperial College of Science, F. E. Smith, C.B.E., F.R.S., President, in the chair.

Atomic Dimensions, by R. G. LUNNON, M.A., M.Sc., was taken as read in the absence of the author.

The paper deals with the diameters of the atoms of the elements, and compares the estimates obtained by various methods *viz.*, (1) Atomic volumes; (2) X-ray analysis; (3) Viscosity of gases; (4) Van der Waal's equation and its modifications; (5) Compressibility; (6) Viscosity of liquids; (7) Viscosity of solutions; (8) Diffusion of ions; (9) Mobility of ions in solutions; (10) Latent heat of solution; (11) Speculations as to atomic laws of force; (12) Scattering of X-rays; (13) Bohr's theory in the case of the hydrogen atom; (14) Ionisation potentials; (15) Band spectra; (16) Chemical constant; (17) Optical rotation; (18) Molecular films; (19) Langevin's theory of diamagnetism; (20) Impacts of a stream of electrons on gas molecules; (21) Density changes in permutite; (22) Melting points of solids.

The results obtained by these methods, of which an extensive bibliography is given, are fairly accordant, and their mean shows that the addition of an inner electron shell gives an increase in diameter of roughly 0.5A.

Edge Tones, by W. E. BENTON, B.Sc., University of Birmingham.

An edge-tone is heard when a stream of air issuing from a slit or hole strikes on a sharp edge, or surface bounded by sharp edges. A brief description is given of previous work, and it is shown that the eddies which give rise to edge-tones conform to a simple Kármán vortex-system. On the assumptions (1) that the distance a from the edge to the slit is always equal to l, the distance between two eddies in the same row, and (2) that tone is destroyed when the edge- when moved across the jet towards still air- crosses the line of eddy centres, one can measure h/l, where h is the separation of the eddy-rows, directly from measurements of the boundaries for tone. From the experiments it is found that at low pressures and with wide slits h/l, for air, $= 0.276$, which may be compared with V. Kármán's prediction of 0.283 for an infinite system in a perfect fluid.

If the edge is moved towards the slit, h, the separation of the eddy-rows, must decrease proportionally. The experiments show that whn the eddies are formed very close to the edges of the slit, and therefore in a field of high velocity-gradient at right angles to the direction of motion, they are deflected towards the middle, or principal, plane of the jet. The amount of this deflection increases very rapidly as a approaches a_0, at which distance tone can only be obtained when the edge lies in the principal plane. The experiments show that with wide slits, when $a = a_0$, then $l = a_0 \cdot h = 0.67d$, where d is the width of the slit. The minimum distance for tone a_0 varies with the velocity v, and the width of the slit.

The results suggest an equation of dynamic similarity :—

$$B \frac{v}{\nu d} = \frac{a_0}{d}^2 - 1.5$$

where B is a number (about 2,000 for air)

and v is the coefficient of kinematic viscosity. By considering the acceleration that produces the deflection, an expression of somewhat similar form can be obtained theoretically. The tonal boundaries in the region of simple tone approach two straight-line asymptotes, equally inclined to the principal plane, which converge at a point 0 near the plane of the slit. If d and d_0 denote the distance of the edge and the minimum distance for tone respectively from 0, the total separation, y of the two boundaries at any listance d is given by the equation :

$$y = \frac{h}{l} d - \frac{h}{l} d_0 e^{m^2(d^2 - d_0^2)}$$

where l/m is approximately equal to d, when the slit is very wide. The measurements of the frequency of the tone and the deductions made from them will form the subject of a subsequent communication.

Curve of Bodies Falling from a Great Height. A demonstration of "An Instrument for Imitating the Eastward Deviation of Bodies Falling from a Great Height," was given by Mr. G. R. Mather.

If a body, initially stationary with respect to the earth, be allowed to drop from a height, it will appear to move eastward as it falls. Newton suggested that this phenomenon might possibly furnish a measure of the earth's rate of rotation, and a photograph of his autograph letter on this subject was shown. The curve showing the trajectory with respect to the earth, as drawn by Newton, was convex to the radius vector drawn to the initial position; and Professor Rankine, in introducing the demonstration, gave an analysis showing that this drawing is correct. Many astronomical text-books, however, give the curve as a parabola concave to the initial radius vector, and the apparatus is designed to show the true state of the case.

The apparatus comprises a large horizontal rotatable table on which a sheet of paper is mounted. A weight carrying a tracing point is designed to slide easily over the paper and is attached to a thread which passes down through a hole at the centre of the turn-table; a second weight is fastened to the other end of the thread, and hangs vertically below the turntable. The table is set in rotation by a gravity motor comprising a weight attached to a string, which is wound round the spindle, and when the motor has gone out of action, so that the speed of rotation is constant, the thread is automatically cut, so that the tracer-weight may be drawn in towards the centre from its initially peripheral position. The curve traced is very similar to that sketched by Newton.

The demonstration acquired a personal interest from the fact that Mr. Mather, who is now 85 years of age, became interested in the subject at the age of 14 through an accident which befell him when playing with a joy wheel improvised from farm machinery.

SOCIETY OF PUBLIC ANALYSTS
AND OTHER ANALYTICAL CHEMISTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, December 2, 1925, Mr. S. F. Burford ,Vice-President, was in the chair.

Certificates were read for the first time in favour of Messrs. Guy Chignell, K. Saito, and Hugh Gower Watts.

Certificates were read for the second time in favour of Messrs. John Douglas Barrett, B.Sc., A.I.C.; Arthur Frank Lerrigo, B.Sc., F.I.C.; Oscar Adolf Mendelsorn, B.Ce.; Harold Edward Monk, B.Sc., A.I.C.; and Eric Voelcker, A.R.C.S.

The following were elected Members of the Society: Messrs. Alexander Bruce, B.Sc., F.I.C.; Sydney George Clarke, B.Sc., A.I.C.; Felix John Theodore Grigg, M.Sc., A.I.C.; John Hanley, F.I.C.; Arthur John Jones, A.I.C.; Henry William Lawrence, F.I.C.; Fred Mattingley, B.Sc., A.I.C.; Clive Newcomb, I.M.S., M.D., F.I.C.; Bartle Frere Sawbridge, M.A., F.I.C.; Harold Jacob Stern, B.Sc., Ph.D., A.I.C.

The following papers were read and discussed :

Measuring the Smoke Pollution of City Air, by J. S. Owens, M.D., A.M.I.C.E.

After dealing with the necessity for measuring smoke pollution, and for a comparison between different cities, the author discussed the various methods based on :—
(a) Measurement of deposit from the air; (b) measurement of suspended matter before it is deposited. The methods of the Advisory Committee on Air Pollution were then described under the headings of : (1) Measurement of deposit by means of standard gauges; (2) measurement of suspended

impurities by means of automatic filters, or records; and (8) measurement with the author's jet dust counter. The last-named instrument has shown the curious variations in smoke impurities in cities from hour to hour. The excessively minute quantities to be dealt with demand the applications of methods more sensitive than those of ordinary analytical processes. For example, the material trapped on dust records from 50 c.c. of air, on an average winter's day in London, weighs about 1/20,000 mgrm., and consists of about 600,000 particles.

2 : 4 *Dinitrophenylhydrazine as a Reagent for Aldehydes and Ketones*, by OSCAR L. BRADY, F.I.C., AND GLADYS. V. ELSMIE.

Aldehydes and ketones can be identified by the crystalline forms, colours, and melting points of the dinitrophenylhydrazones which they yield with 2 : 4 dinitrophenylhydrazine. A solution of the hydrochloride is a suitable reagent for aldehydes and ketones soluble in water; it gives a filterable precipitate with 0.008 grm. of acetone or acetaldehyde. The characteristics of the 2 : 4 dinitrophenylhydrazones of a number of the commoner aliphatic aldehydes and ketones are described.

The Determination of Phosphoric Acid as Magnesium Ammonium Phosphate, by GUNNER JÖRGENSEN.

The most reliable method of obtaining magnesium ammonium phosphate of the correct composition is to precipitate it from a nearly boiling solution (accuracy about 1 : 1,000). In the author's experience this is the only sufficiently exact method for determining phosphoric acid in mineral phosphates and fertilisers. The author's molybdic magnesium method has been the official Danish method for nearly twenty years. Precipitation of ammonium phosphomolybdate in the cold is less accurate (accuracy about 1 : 100). Precipitation of magnesium ammonium phosphate from a cold solution gives a precipitate so much affected in composition by the conditions of precipitation that the method is unlikely to be made really satisfactory.

On the Effect of "Blowing" on the Composition of Certain Fatty Oils, by C. H. THOMSON.

The effect of "blowing" on a large scale on the composition, the viscosity, and other constants of cottonseed, whale, sperm, and shark oils, has been studied. The rise or fall in the values is simultaneous at each stage of the process, but the rates of change are not the same. It is shown that the changes produced by varying the conditions of "blowing" are not comparable, except that the viscosity and refractive index rise simultaneously. None of the oils after "blowing" yields ether-insoluble bromides.

SIR OLIVER LODGE ON THE BEGINNING AND END OF THE WORLD.

In the course of the Huxley Lecture at the Charing Cross (London) Hospital on December 8, Sir Oliver Lodge based his lecture on Evolution. He said they knew what happened when light encountered a particle of dust, in other words, an atom of matter. It had been investigated in our laboratories and was known as photo-electricity—an electron jumped out of the atom and the atom was ionised. This ionisation of matter by light was becoming, or was likely to become, familiar in medicine. The photographic and chemical actions of light were constantly being studied—its action in polymerising sap in the leaves of trees and vegetation generally, the action of light on the skin also, and its familiar, though remarkable effect on the nerve-supplied retina of the eye.

How were these chemicophysical actions to be accounted for? Surely by the photo electric property, that was, by the power of waves of the right frequency of vibration to eject an electron from an atom. This last process was called ionisation; for the atom, having lost an electric charge of one sign, was now charged with the opposite sign. It was an ion. It was actively and chemically fierce. It was seeking to combine with another. Chemical affinity was in full blast, and the molecular changes is in protoplasm, in silver salts, and in the leaves of trees, occurred. In the retina the nerves were bombarded by the ejected electrons, each striking with an energy appropriate to the frequency of the received vibrations, thus giving the different colour sensations, through the extraordinary interpretative power of the mind through its organ, the brain. The destructive influence of this action on micro-organisms such as an anthrax bacilli, when they were exposed to ultra-violet light, was well known; and the health-giving power of these same ultra violet rays was constantly receiving more and more expert attention.

A study of radiation radiation of all kinds- had proved of late years intensely illuminating. Thereby that mysterious but fundamental entity, the quantum, had been detected, and thereby the temperature, the constitution, the age, the speed, the history of the various cosmic masses had been and was being elucidated; thereby the formation of woods, and the growth of vegetation on which animal life depended, had been explained; and now the sanitary ,invigorating and beneficent work of sunlight on the human organism was being more and more appreciated, and more and more studied and applied by those who had the requisite training, and who would watch for the dangers of excess, and regulate the application of any kind of ray with patience and wisdom. He hoped that a recognition of the electric and ionising power of such rays, which he urged as a reasonable explanation of their chemical and physiological activities, might be a hint in the right direction to those engaged in that work.

Dealing with cosmic evolution, he said it would seem as if the universe as a vital and going concern, must have had a beginning and must have an end. The beginning was the formation of nebulæ 200 million years ago That end would apparently be the disappearance of matter and the existence once more of an ether filled with perpetual remnants of radiation travelling out in all directions towards infinity with the speed of light at a date incomparably remote. But was that the end? Need there be any end or any beginning? The various stages of cosmic evolution were all concurrent and co-existent, and had it not always been so? He doubted whether the idea of termination in any form was tenable, and suggested a theory of the dust of the universe, driven to the confines of space by the pressure of light, receiving the daste radiation, and being ionised by it, chemical activity thus coming toon full blast. Thus would begin once more the clash of atoms, the formation of nebulæ, the birth of stars, and ultimately of planets.

The Glass Research Association Bulletin No. 14 has just appeared. It contains a review of the work of the Association and suggestions are made with regard to future researches on glass and refractory materials. The report was primarily prepared for those connected with the Association, and is apparently not for sale.

ROYAL SOCIETY OF ARTS.

January 21, 1925.

Irish Glass, Old and New, by MRS. GRAYDON-STANNUS.

The history of Irish glass, like that of so many other arts connected with the "Ould Country," is a record of wonderful artistic success combined with financial failure. Unfortunately, the earliest records of the industry are lost and it is impossible to speak definitely of the existence of glass houses in Ireland prior to the 16th century. On the other hand there are many old documents in existence which refer to "Glass Workers" and so make it extremely probable that such factories *did* exist, but these documents often consist merely of an old account or a receipt relating to work done, and may use the word "Glass-worker" when they mean a glazier, and such evidence therefore does not establish the fact beyond dispute. However, at the end of the 16th century there undoubtedly was a factory (or "Glass House") erected in County Cork, in all probability at a spot even to-day known as "Glasshouse" and which is not far from Curryglass. From that time onwards there are ample evidences of glass houses having been erected in various parts of the country, but in the earliest days of the industry it is extremely difficult to say definitely what particular type of glass any individual factory produced.

When we come to the year 1630 (or thereabouts) we find ourselves on surer ground, as about this time glass was being made on a large scale in Dublin, and that city remained famous for its productions from that date right up to 1896. One of its most noted factories, known as the Round Glass House, was in 1729 and onwards, producing really choice specimens, such as dessert dishes (with handles and feet), bowls and goblets, etc., of the most artistic designs and wonderful workmanship. Very beautiful glass, too, was made in Marlborough Street from 1771 onwards by a firm named Williams, who specialised in chandeliers, candlesticks, bowls, decanters, bottles and even bells. A number of factories were afterwards opened which produced every kind of white and coloured glass associated with Ireland. Many fine specimens still exist and mention must be made of Pugh's productions, which, though rather late from the collector's

point of view, are deserving of the highest praise from an artistic standpoint. He was noted for his lustre cutting and his moulded pieces, many of which were very quaint, strongly resembling Bristol but rather heavier in metal and darker in tone. Mention of Bristol reminds me that many of the finest English craftsmen from Bristol, Stourbridge, and other places, migrated to Ireland when glass-making was flourishing there.

Before, however, we consider the variations in colour, texture, etc., between the different makes of Irish glass, I think we had better pay a fleeting visit to the various localities in Ireland where glass wre produced in large quantities.

A factory at Ballycastle in Antrim flourished from 1755 to 1790, its output consisting of bottles, heavy rummers and various kinds of coarse glass of the useful but non-decorative variety.

Belfast figures very largely in the list of glass producing towns and was in the forefront from *circa* 1781 to 1870. It was noted for fine flint glass of heavy character, but, so far as my experience goes, white in colour as compared with other Irish products. The cutting of Belfast glass was ornate and deep, and engraving was largely indulged in. It should be noted that glass was sent to Belfast from other parts of Ireland to be decorated, and there is no doubt that foreign engravers were employed there. Very fine candlesticks and lustres were made by a firm named McDowell, mostly of Georgian and Adam designs.

We now return to Cork, which was one of the most famous of all Irish glass centres.

As I mentioned just now, records show definitely that a glass house existed in Cork in the 16th century, but it is impossible to find out what type of glass was made there at that date. In dealing with questions of output, therefore, we can only cover a period extending from *circa* 1782 to 1844, during which time some of the most beautiful glass was manufactured. Here again, engraving was practised and some of the finest gilding was done in Cork. It produced finely cut glass of every description and was famous for rummers and decanters of both heavy and light varieties. There are still many of the latter in existence and a few of them are marked pieces, which place their identity beyond all dispute. These are impressed on the bottom, the most usual markings being "Cork Glass Co." and "Waterloo Co., Cork." Such marked pieces are, of course, greatly sought after by collectors, and are very valuable. I have several in my possession, and have brought one or two to-night for you to see.

I have also brought a card of membership of the Cork Glass Cutters' Union, which is of considerable interest. It is, unfortunately, not dated, but it has the name Donovan on it as being the printer, and exhaustive enquiries in Cork have shown that there has been no printer of that name there for somewhere about 90 years. This fact adds largely to our interest in thi card. Apart from the fact that a trades' union existed in Cork 90 years ago, this card shows us some types of glass produced there, and to my mind proves, beyond dispute, that heavy lustre cutting was done in Cork though there are experts who will tell you that that was a Dublin speciality. If lustre or "pillar" cutting was not one of their specialities, why should they have made a point of reproducing it on their trade card?

Cork was also famous for its engraving, particularly on blown glass, while after 1800 whole dessert services of beautiful colour, and in a great variety of cuttings were produced, and many are still in existence, though naturally incomplete or made up with Irish glass of later dates.

In 1771 a glass house was opened at Drumrea, not far from Dungannon, which specialised in coloured ware usually known as "Dungannon" glass. It also produced clear glass which was very similar in appearance to Cork, but rather whiter. Its finest coloured products were in green and amber, and comprised bottles, wines, jelly glasses, epergnes and drops for candelabra and chandeliers. Here I may mention that most of the chandelier drops were made in England.

Newry flourished as a glass centre from 1790 to 1847 and specialised in table glass generally of the heavy varieties, both plain and cut. Most of the Newry output was flint glass. One of the earliest glass-houses in Ireland was built on the Stannus property in Portarlington in 1670, but very little is known of its particular productions, and it soon closed down for lack of financial support. If I had been alive then I think its history would have been very different. I am afraid that is very egotistical, but if one can run a glass house successfully in these days in the face of trades' unions,

Socialist Governments, rings, factory inspectors and other difficulties, I cannot help thinking that our ancestors who paid wages of anything from 6s. to 10s. a week were living in a manufacturer's paradise only they did not know it.

It was the sort of Heaven we glass manufacturers hope to do to when we die. The heat of the other place will have no terrors for us.

We still have a tumbler in our possession which was made at Portarlington, and I believe some wine glasses still exist, but beyond that I cannot say what particular types of glass the factory was responsible for.

(*To be Continued Next Week.*)

Readers requiring information and advice respecting Patents and Trade Marks will receive the same free from Rayner & Co., Patent Agents, 5, Chancery Lane, London, W.C.2.

FORTHCOMING EVENTS.

INSTITUTE OF MECHANICAL ENGINEERS.

Stories Gate, London, S.W., December 18, at 7 p.m. " The Work of the Mechanical Engineer."

AERONAUTICAL ENGINEERS.

At the Rooms of the Royal Society of Arts, John Street, Adelphi, London, on December 18, at 7.30 p.m.

ROYAL SOCIETY OF ARTS.

(Dominions and Colonies Section.)

On January 5, 1926, at 4.30 p.m. Mons. Henry D. Davray, C.B.E., Chevalier de la Légion d'Honneur, formerly war correspondent for *Le Petit Journal* in North Africa, " French North Africa."

THE CHEMICAL SOCIETY.

The Library of the Chemical Society will be closed for the Christmas Holidays at 1 p.m. on Wednesday, December 23, and will re-open at 10 a.m. on Tuesday, December 29.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

29,778. Badische Anilin & Soda-Fabrik. Manufacture of iron carbonyl. November 25th.

30,074. Ingham, T. Manufacture of alginic acid and alkaline alginates. November 28th.

30,106. Naamlooze Vennootschap Philips' Gloeilampenfabriken. Process of separating a mixture of hafnium and zirconium. November 28th.

29,884. Wilhelm, F. Process of working up acid resins obtained from refining mineral oil derivatives. November 26th.

Specifications Published.

217,508. Cosmic Arts, Inc. Treatment of natural alkaline salts.

242,741. Humphrey, H. A., & Synthetic Ammonia & Nitrates, Ltd. Production of combustible gases.

231,446. Soc. of Chemical Industry in Basle. Manufacture of dyestuffs containing chromium.

230,855. Meisel, B. Centrifugal pumps, compressors and the like.

Abstract Published.

240,955. -Methanol and higher alcohols.—Badische Anilin & Soda Fabrik, Ludwigshafen-on-Rhine, Germany.

The synthesis of methanol by the cataly-

tic hydrogenation of carbon monoxide under pressure is effected in the absence of iron, that is to say, the catalytic materials must be free from iron, the inner walls of the reaction chamber must not consist of iron, and the reaction gases must be freed from iron particles or volatile iron compounds such as iron carbonyl. The reaction conditions may be varied by the use of temperatures of 250-600° C., and of pressures from 50 atmospheres upwards, the resulting methanol being either pure or mixed with higher alcohols. Examples are given of the use of a mixture of chromium oxide and manganese oxide in a copper-lined tube, and of a mixture of chromium oxide and zinc oxide in an aluminium-lined reaction vessel, the gases being circulated through the reaction chamber and condenser. Other contact substances mentioner are a mixture of copper oxide and chromium oxide, or of the oxides of cadmium and vanadium; metal alloys such as chromium-manganese, and copper-zinc; masses containing oxides non-reducible under the conditions of working, *e.g.*, uranium and aluminium; and mixtures of such metals as copper, silver, lead and zinc with a metal oxide or salt acting as a promoter. When contact masses containing a difficulty-reducible metal oxide with a little potassium carbonate are employed, and preferably with a higher percentage of carbon monoxide and a reduced velocity of the gas current, higher alcohols such as propyl, butyl and amyl alcohols are formed in addition to methanol. In every case nickel and cobalt must be excluded from the catalytic materials.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

CUTRALOL.

459,687.—Chemical substances used for agricultural, horticultural, and sanitary purposes. — Actien-Gesellschaft fur Anilin-Fabrikation, An der Treptower Brucke, Berlin, Germany. November 18th, 1925.

RUSTICOFF.

461,829. A chemical substance used as priming for metals. Murphy & Son, The Cedars, Sheen Lane, Mortlake, London, S.W.14. November 18th, 1925.

LABRISOL.

463,243.—Chemical substances used for Agricultural, Horticultural, Veterinary and Sanitary purposes.—Brisbane Laboratories, Ltd., 15, Brisbane Street, Camberwell Green, London, S.E.5. December 2nd, 1925.

"HAPPY VALLEY."

462,926. Medicines for human use. Kuro, Ltd., 25, Grace Street, Leeds. December 2nd, 1925.

THE LATE GEORGE DAVENPORT.

The late George Davenport, who died on November 8, spent nearly all his business life in the service of the Royal Society of Arts, and he was 72 years of age at his death.

THE CHEMICAL NEWS.
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BENZOYLMETHYLGLYOXIME AS A PRECIPITANT OF PALLADOUS SALTS.*

By J. HANUŠ, A. JILEK AND J. LUKAS.

Organic compounds used in analytical chemistry as reagents for detection or determination of cations or anions are acquiring greater importance. Among these, glyoximes are largely used in gravimetric analysis. Čugajev (*Z.f. arnog. Chem.*, 1905, XLVI., 144), was the first to point out reactions between glyoximes and elements of the eighth group of the periodic table. These elements give, with di-substituted glyoximes, complex compounds many of which are insoluble and can be used in detections or determinations. Čugajev (*Ber.*, 1905, XXXVIII., 2520), used dimethylglyoxime for detecting traces of nickel. It was later used by Brunck for estimating nickel and by Wunder and Thüringer for estimating palladium. Estimating nickel, Atack (*Trans.*, CIII., 1317) recommended diphenylglyoxime, which is more sensitive and also less soluble. But there are many di-substituted glyoximes which were not studied. We first studied the behaviour of di-substituted glyoximes with more acidic substituents. Wunder and Thüringer showed dimethylglyoxime is unsuitable for precipitating palladium; it also precipitates platinum and gold. Since bi-valent palladium is considered more electropositive than tetravalent platinum, the more acid substituted glyoxime should precipitate palladium rather than platinum. We therefore prepared a glyoxime with an acyl and methyl group. Such a compound—benzoylmethylgloxime, made as a white crystalline solid by Ceresol (*Ber.*, XVII., 872). The alcoholic solution precipitated palladous salts even in acid solutions, and gave rise to yellow amorphous precipitate. This melted at 254-6° C. Analysis showed that two molecules of dioxime correspond to one atom of palladium, and the yellow precipitate has the formula

$$\begin{array}{lcl} C_6H_5.CO.C = NO & Pd & - NO = C.CO.C_6H_5 \\ \quad\quad\quad\; | & & \quad\quad\quad\; | \\ \quad\; CH_3.C = NOH & & HON - C.CH_3 \end{array}$$

No element of the platinum group was precipitated by benzoylmethylglyoxime. Neutral tetravalent platinum solutions gave a slight brownish precipitate readily soluble in hydrochloric acid. Rhodium, ruthenium, and iridium were neither precipitated in acid solution nor in ammonia, nor was gold. Acid solutions of the remaining elements give no precipitate with benzoylmethylglyoxime. Silver, manganese, and nickel salts in ammoniacal solutions only give a feeble yellow brown or green precipitate. All these precipitates dissolved in acids. Qualitative and quantitative reactions show that benzoylmethyl glyoxime can be recommended as a reagent for detection and determination of palladium not only in the presence of the platinum group, but in the presence of others. The precipitate with palladium salts can be directly weighed after drying at 105-110° C. On the other hand, the precipitate of palladium salts with W. Smidt's (*Z. anorg. C.*, 1913, LXXX., 335) α-nitro-β naphthol must be ignited to metallic palladium. Errors in weighing palladium are greater than those for its benzoylmethyl glyoxime compound containing 20.04 per cent. Pd. Since benzoylmethylgloxime is a very sensitive reagent for palladium and it does not precipitate other elements in acid solutions, it may be regarded as a specific precipitant for Pd.

EXPERIMENTAL.

Composition and properties of the Precipitate.—.7592 g. pure Pd. were dissolved in aqua regia, twice evaporated with hydrochloric acid to dryness to obtain palladous chloride, taken up in water, acidified with 5 c.c. hydrochloric acid, transferred to 500 c.c. flask, and made up with water. This standard solution was used throughout. A portion was boiled and precipitated with 2 per cent. alcoholic benzoylmethylgly-

* Presented before the Czech Academy, Prague.

oxime in excess. The yellow precipitate was filtered off under suction, washed with 1.5 per cent. hydrochloric acid, then with water and dried at 100-5° C., to constant weight. .1100g. precipitate were ignited and reduced in hydrogen, giving .0220g. Pd. corresponding to 20.54 per cent. Pd.; $C_{20}H_{18}N_4O_6$ Pd. contains 20.67 per cent. (Pd. - 106.7). We tried to determine nitrogen by Kjehldahl's method, but the results varied: 9.11, 9.49, and 9.66 per cent. No improvement was observed when Kruger and Dafert's method was used. Therefore, nitrogen was determined by Dumas' method. .1150 g. substance gave 11.4 c.c. at 20° C., and 740 m.m. N = 11.18 per cent (theoretical, 10.84). Thus, the formula of this compound can be written:

$$\begin{array}{ccccccc} C_6H_5.CO & C & NO & Pd & ON & & C.CO.C_6H_5. \\ & | & & & & & | \\ & H_3C.C & - & NOH & & HON & C.CH_3 \end{array}$$

The above precipitate does not decompose if maintained at 110° C., it is not hygroscopic. It is insoluble in water and dilute hydrochloric acid. The reaction between palladium and benzoylmethylglyoxime takes place even when only small amounts of Pd are present. Thus 1 c.c. of the palladium solution diluted to 100 c.c.. .6 c.c. (9.12. 10^{-7} Pd.) of this solution was measured by burette and made up to 100 c.c., acidified, boiled, and 1 c.c of 2 per cent. alcoholic benzoylmethylglyoxime was added and allowed to stand 12 hours. No precipitate appeared. But when 2 c.c. instead of .6 c.c. were taken, a yellow precipitate appeared after 9 hours' standing. The Pd. present was .000001216 g., so that the sensitivity of this reaction is one in a hundred million. The precipitant was always used 38 per cent. in excess.

Experiments with Palladous Solution. - The strength of the standard palladous solution was determined by Gutbier and Falcov's hydrazine sulphate method. .0368 g. Pd were found in 24 c.c. standard solution instead of the calculated .03644 g., so that agreement was satisfactory. All experiments were carried out as follows :- 100-150 c.c. solution were treated with 38-40 per cent. excess of precipitant and added with stirring to the hot acid solution. The precipitate was either filtered off at once or after 12 hours' standing, according to the concentration of the solution. It was washed with 200 c.c. water containing 2.5 c.c. hydrochloric acid, then with water till reation with silver ion disappeared, and dried for 2-3 hours at 100-5° C. We preferred to filter through the porous porcelain crucibles recently introduced. Porous crucibles filter very quickly and give a clear filtrate. The porous mass absorbs less from the filtrate.

Table I. gives our results : -

TABLE I.

Pd. Mg.	Dioxime added c.c.	Ppt. mg. found	Ppt. mg. calc.	Pd found
37.96	10	181.7	183.9	37.5
7.59	8	36.0	36.8	7.43
1.52	1	7.0	7.3	1.45
.3	1	1.2	1.4	.25
22.77	6	110	110.3	22.7
22.77	6	108	110.8	22.4
.15	1	.7	.78	.145
60.78	16	294.6	294.1	60.8

In the last three experiments, 1 c.c. HCl was added.

As palladium benzoylmethylglyoxime is voluminous, it enables minute amounts of Pd to be determined, and large amounts were not used. In such cases it is best to let it settle for 12 hours. Warm neutral or weakly acid palladous chloride was treated with 40 per cent. excess alcoholic benzoylmethylglyoxime with boiling after standing 12 hours. The precipitate was filtered off, washed with dilute hydrochloric acid, then with water till reaction free from chloride ions. The weight of precipitate dried at 100-110° C., multiplied by .2064, gave the weight of palladium.

Determination of Palladium in Presence of Gold. A standard gold solution was made by dissolving 1 g. $AuCl_3$ in 1 c.c. HCl diluted with water and made up to 250 c.c. The strength of this solution was found by adding oxalic acid in excess; .0918 g. present in 50 c.c. To separate palladium from gold by the benzoylmethylglyoxime method, various proportions of both solutions were mixed and analysed. The total volume was 100 c.c. ,and 1 c.c .HCl was always added. The procedure was the same as that above. In two cases the gold was also determined in the filtrate.

(To be continued.)

THE STRUCTURE OF TIN.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The constitution of an atom of tin was given in *The Chemical News*, 1920, CXXI., 184, as ZrSi for the following reasons.

1.—The atomic weights of Zr, Si and Sn are 90, 28 and 118 respectively, and 90 + 28 = 118.

2. Cassiterite (SnO_2) is found in parallel position with Zircon ($ZrSiO_4$).

3. If the two non-metallic valences of Zr are quiescent with the two metallic valences of Si, the valency of Sn, dibasic and diacidic, is explained for all three are tetrads and similar to one another.

This structure for Sn will now be proved to be correct quite independently by means of the laws of relative volume and heat of formation.

TABLE I.

The Relative Volumes of Sn.

	Sn	–	Zr	+	Si
(4)	16.02	-	3	+	13.02
(5)	18.04	=	5.02	+	13.02
(6)	16.55	=	5.02	+	11.53

13.02 and 11.53 were shown to be volumes of Si in *The Chemical News*, 1921, CXXIX, 47. 3.0 was shown to be the volume of Zr when forming a constituent part of Bi and Pt in C.N., 1921, CXXIX, 2. 5.02 will be shown later to be a volume of Zr in many other elements.

TABLE II.

Experimental Data Illustrating Table I.

	Relative Volume	Theor S.G. at 15° C.	Obs. S.G.	
(7)	Sn 16.02	7.37	7.373	Deville
(8)	$PbSn_4$ 18.17 + 4(16.02)	8.24	8.2847	Pillichody
(9)	$PbSn_5$ 18.17 + 5(16.02)	8.10	8.093	Calvert
(10)	Pb_2Sn 2(18.17) + 16.02	10.12	10.11	Riche
(11)	Pb_3Sn 3(18.17) + 16.02	10.48	10.421	Calvert
(12)	Pb_5Sn 5(18.17) + 16.02	10.74	10.751	Calvert
(13)	BiSn 21.29 + 16.02	8.77	8.772	12°.6 Carty
(14)	$BiSn_2$ 21.29 + 2(16.02)	8.84	8.889	14° Carty
(15)	$BiSn_3$ 21.29 + 3(16.02)	8.118	8.112	14° Carty
(16)	Bi_2Sn 2(21.29) + 16.02	9.147	9.145	Riche
(17)	Bi_4Sn 4(21.29) + 16.02	9.48	9.484	Riche
(18)	Bi_2Sn_3 2(21.29) + 3(16.02)	8.51	8.506	Riche
(19)	Sb_4Sn 4(17.91) + 16.02	6.78	6.781	18°.5 Long
(20)	Sb_2Sn 2(17.91) + 16.02	6.86	6.844	18°.8 Long
(21)	Ag_4Sn 4(9.78) + 16.02	9.92	9.958	15° Holzmann
(22)	$AgSn_2$ 9.78 + 2(16.02)	8.20	8.228	16°.8 Holzmann
(23)	$AgSn_3$ 9.78 + 3(16.02)	7.97	7.986	19°.3 Holzmann
(24)	CuSn 7.02 + 16.02	7.9	7.90	Riche
(25)	$CuSn_2$ 7.02 + 2(16.02)	7.65	7.58	Miller
			7.74	Riche
(26)	$CuSn_3$ 7.02 + 3(16.02)	7.57	7.58	Riche
			7.606	Calvert
(27)	$CuSn_4$ 7.02 + 4(16.02)	7.52	7.50	Riche
			7.55	Thurston
(28)	$CuSn_5$ 7.02 + 5(16.02)	7.49	7.487	Thurston
(29)	Cu_2Sn 2(7.02) + 16.02	8.12	8.15	Riche
(30)	Hg_2Sn 2(14.65) + 16.02	11.886	11.8816	Kupffer
(31)	HgSn 14.65 + 16.02	10.86	10.8447	Kupffer
			10.869	14°.2 Holzmann
(32)	$HgSn_2$ 14.65 + 2(16.02)	9.317	9.3185	Kupffer
			9.314	Calvert
(33)	$HgSn_3$ 14.65 + 3(16.02)	8.82	8.8218	Kupffer
(34)	$HgSn_4$ 14.65 + 4(16.02)	8.52	8.510	Calvert
(35)	Sn_2Sb 2(16.02) + 18.25	7.06	7.07	19° Bodeker
(36)	SnO 16.02 + 4.45	6.55	6.6 - 6.45	0° Ditte
(37)	$SnCl_2.2H_2O$ 16.02 + 15.085 + 28.01 + 2(14.08)	2.74	2.759	Playfair and J.

			2.71	15°.5 Penny
(38)	SnO_2 16.02 + 2(4.45)	6.019	6.019	(artif.) Leeds
(39)	Sn 18.04	6.54	6.53	6.56 Nostrand
(40)	SnO 18.04 + 2.51	6.51	6.6	6.45 0° Ditte
(41)	SnO_2 18.04 + 2.51 + 4.45	6.0	6.019	Leeds
(42)	$SnAs_2$ 18.04 + 2(11.88)	6.57	6.56	Descamps
(43)	$SnBr_2$ 18.04 + 2(18.06)	5.18	5.117	17° Nostrand
(44)	SnO_2 16.55 + 2(2.51)	6.954	6.952	Nepmann
			6.96	Mohs
(45)	$Am_2SnCl_6.3H_2O$ 2(23.87) + 16.55 + 4(15.085) + 3(14.08)	2.10	2.104	Playfair
(46)	$K_2SnF_6.H_2O$ 2(22.29) + 16.55 + 6(5.42) + 14.08	3.05	3.053	Topsoe
(47)	$K_2SnCl_6.3H_2O$ 2(18.05) + 16.55 + 4(15.085) + 3(14.08)	2.528	2.514	Playfair
(48)	Am_2SnCl_6 2(23.87) + 16.55 + 6(15.085)	2.371	2.381	Schroder
(49)	Sn_2As 2(16.55) + 11.38	7.00	7.001	18° Bodeker
(50)	K_2SnCl_6 2(22.29) + 16.55 + 6(15.085)	2.697	2.687	Nostrand

TABLE III.

	Heat of Formation of Sn.	Original Volume	Rel. Vol. in combination	Change of Volume
(51)	28608 = 120 × (2.02) × 118	16.02	18.04	2.02
(52)	0 120 × 0 × 118	16.02	16.02	0
(53)	7505 120 × (0.53) × 118	16.02	16.55	0.53
(54) aq.	18040 120 × (1.27) × 118	16.02	17.29	1.27

TABLE IV.

Experimental Data Illustrating Table III.

	Heat of Formation.		Theor.	Obs.	
(55)	Sn.O 28608 + 90155		97552	68090	
	(corresponds with No. 40)				
(56)	$Sn.O_2$ 28608 + 90155 + 71515		189067	137200	
				141800	
	(corresponds with No. 41)				
(57)	$Sn.Br_2$ 28608 + 2(45244)		61885	61500	
(58)	$Sn.Br_4$ 28608 + 2(45244) + 2(18060		98005	98000	
(59)	aq. $Sn.Br_4$ 28608 + 2(52930) + 2(18060)		113877	114600	
(60)	$Sn.Cl_4$ 28608 + 2(56786) + 2(28010)		180989	129800	liq.
				127250	
(61)	Sn.O 0 + 71515	-	71515	70700	
	(corresponds with No. 36)				
(62)	SnO_2 0 + 2(71515)		148080	141800	
	(corresponds with No. 38)				
(63)	$Sn.Cl_4$ 0 + 56786 + 3(28010)	--	125816	127250	
(64)	$Sn.Cl_2$ 0 + 56786 + 23010	-	79796	80900	
				80790	
(65)	$Sn.Cl_2$.aq. 7505 + 23010 + 68870	-	79875	81140	T
(66)	$Sn.O_2.H'_2O$ 7505 + 2(71515) 3205	=	132820	133500	
(67)	aq.$Sn.Cl_4$ 18040 + 2(68870) + 2(28010)	--	155720	157170	T
(68)	aq.$Zn.Cl_2$ - 14900 +2(68870)	=	112840	112840	
				113080	

HEAT OF DEPOSITION OF Sn.

When (65) and Zn produce (68) and Sn,

− 7505	becomes	0
28010	becomes	63870
0	becomes	14900

(69) 7505 + 63870 28010 14900 -- 33465 31700 Thomsen

HEAT OF ADDITION.

When (65) and Cl_2 produce (67),

− 7505	becomes	− 18040
0	becomes	63870
0	becomes	28010

(70) − 18040 + 7505 + 63870 + 28010 = 76845 76080 Thomsen

No. 57 is given as an example to demonstrate the impossibility of calculating the H.F. of a compound with the certainty of its being correct, without the previous knowledge of the relative volumes of the elements. The H.F. 45244 of Br has been shown in a great many cases to correspond with the vol. 28.09; but in (No. 48) $SnBr_2$, the vol. of each Br atom happens to be 18.06 as previously demonstrated in some cases. Therefore the H.F. of this compound is incorrectly calculated unless there is another form of the molecule which gives a very different S.G.

The significance of this proof of the structure of an atom of tin cannot be adequately appreciated without considering the proved structures for about 20 other elements already given in this periodical.

SUMMARY.

The structure of Sn, which had previously been given as ZrSi for three different reasons involving atomic weight, mineralogical facts and valency, is here proved to be correct—

(i) since each one of the three volumes found by numerous data of specific gravity has a definite structural meaning in that it can be split up into volumes of Zr and Si;

(ii) since all three are connected by the law of heat of formation, which is very sensitive, for the change of volume has to be multiplied by a very large number, 14160 (= 120 × 118), which puts the results completely outside any possibility of accident;

(iii) since one of the values of H.F. in large calories is equal to one of the relative volumes (18.04), as in several other cases already given.

LOW TEMPERATURE CARBONISATION OF COAL. PART I. TREATMENT OF COAL AT 500° IN FISCHER'S ALUMINIUM RETORT.

By AKIRA SHIMOMURA.

ABSTRACT.

In order to obtain a comparative survey of various coals unled low temperature carbonisation, 16 kinds of coals of oriental origin (covering 8 bituminous coals, 4 semi-anthracite coals and 4 anthracites) were treated in Fischer's aluminium retort at 500° and the quantity and the quality of the resulting liquids, gases and the semi-coke, together with the rate of evolution of gases and various relations between the natures of the original coals and those of the products of distillation were studied.

The coal, which is itself a highly intricate mixture of extremely complex compounds, whose natures are far from being clear, yields on carbonisation numerous products of equally complicated nature. The yields and natures of these products are influenced not only by the nature of the original coal, but also by various conditions at the time of carbonisation among which the temperature plays the most important rôle.

The results obtained are only true of the carbonisation up to and at 500° and in the apparatus used. The same material may, of course, give different results if carbonised at different temperatures or in different apparatus, especially in a plant on a large scale, which generally has a tendency to give less tar and more gas and ammonia whatever the structure of the retort may

be, than experimental apparatus in a laboratory. In the circumstances, the above results are useful in giving a *comparative* survey of various coals under low temperature carbonisation.

(*Memoirs, College of Chemistry, Tokio University.*)

ABSTRACTS.

CULTURE PEARLS.

A new method to distinguish the natural from the cultivated pearl, invented by Mr. Szilard, is based upon the difference in density of the pearly material and mother of pearl, employing a liquid with an intermediary specific density. This liquid is a mixture of methylene iodide and naphthalene monobromide in which only Oriental pearls float.

La Nature.

TRANSFORMATION OF SULPHUR INTO SULPHATES BY MICROBIAL ACTION.

Certain microorganisms taken from a soil mixed with sulphur, are capable, as previously demonstrated by M. G. Guittoneau, of rendering this metalloid soluble in the state of hypophosphites, whilst oxidising the organic acid of an ammoniacal salt (succnate) in a synthetic nutrient solution.

In this same nutrient solution and in presence of suitable quantities of ammonium succinate, he obtained by microbial association, an important formation of sulphates. It sufficed to add to the action of the hyposulphite producers that of a micro-organism isolated from the same soil and capable of transforming the hyposulphites produced into sulphates. The bacillus which transforms the hyposulphite into sulphate is a mobile bacillus which does not retain colour by the gram method, slowly liquefies gelatine, makes peptonised bouillon turbid, and in which it also forms a mucous deposit.

Comptes Rendus.

FRENCH AGRICULTURAL RADIOACTIVE STIMULANTS.

Radioactive products are often presented to agriculturists under the name of radioactive fertilisers, and this may give an erroneous idea regarding the method of employment of substances which are not really fertilisers but merely stimulants of vegetation and fertility.

These products are sold according to their activity, estimated by that of black uranium oxide, taken as standard of comparison. Activity is usually 0.08 to 0.10. Examination can be made at the central laboratory for the suppression of fraud where there is a special radioscope, by means of which a satisfactory degree of precision can be obtained in measurement of these slight activities, on large surfaces. The electrode connected with the gold leaf is a grid made of little brass rods and not a plate, in order to decrease the capacity of the insulated system. There are three compartments in the fertiliser box and the central one is used or all three.

The uranium oxide standard is a disc, 5 centimetres in diameter, and it gives much the same current whatever the position in the fertiliser box. Precision of measurement attains 2% for a fertiliser which does not give any emanation. Precision is less great with fertilisers giving emanation.

Composition.

Radioactive stimulants are, owing to their origin, very complex and variable, whilst the action of some of their constituents is, perhaps, far from negligible. When, for example, we consider carnobite, which is a sandstone impregnated with uranium and potassium vanadate, the residue from treatment of the mineral will contain sand in great excess, but there will also be vanadium, a little uranium, and small quantities of iron, lime, etc.

Some of these substances, which, during chemical treatment, have been attacked by energetic reagents, are, perhaps, in a particularly active state. Moreover, the last stage of chemical treatment being with strong acids (hydrochloric or nitric) there should be traces in the residue, in spite of washing and drying.

Although pitchblende residue does not contain vanadium, it has a yet more complex composition, as can be noted by analysis.

Autunite is a decomposed granulite, impregnated with a double uranium and copper phosphate. Phosphates are soluble in the hydrochloric acid employed to extract radium. Were the residue very carefully freed from acid by repeated washing, it would, no doubt, be suitable for agriculture if its activity were a little greater, but in most cases it is less than 0.02. Ordinary

autunite has an activity of about 0.04 and its direct use would, according to some reports, have given more uniform results than that of its residue. The price of this mineral, though relatively high, does not appear to make its utilisation impossible. In all products the radio-active substances belong to the uranium-radium group.

PREPARATION.

The radiferous minerals being finely ground down to facilitate chemical treatment for extraction of the main part of the radium, the residue does not usually require any further grinding. After the final treatment with acid and subsequent washing, the residue is separated in large press filters. It would probably be useful to again dilute the residue with water and again dry it, in rotary dryers, for example, before grinding in little mills. Sometimes mixtures are made with substances of different activity so as to obtain about 0.04, mixing being made under the mill-stones.

Poor minerals are ground in ball mills or centrifugal crushers, and then dried, if necessary.

Some manufacturers supply mixtures of fertilisers and radioactive stimulants.

Le Génie Rural.

PHARMACISTS IN THE ARMY.

Mr. H. Williams asked the Secretary of State for war whether, in view of the fact that prescriptions containing dangerous drugs and poisons may be dispensed in the Royal Army Medical Corps by persons other than medical officers or pharmacists, he will give instructions that such prescriptions shall in future only be dispensed by a medical officer or pharmacist, or under the direct supervision of a medical officer or pharmacist by whom the quantity of the dangerous drugs or poisons shall be checked?

Captain King: All Army dispensaries are under the direct supervision of a medical officer. The only persons, other than medical officers, who may make up prescriptions in these dispensaries are qualified Army dispensers, and they may only make up prescriptions signed by a medical officer. I am not aware of any reason for considering that the present procedure is not satisfactory.

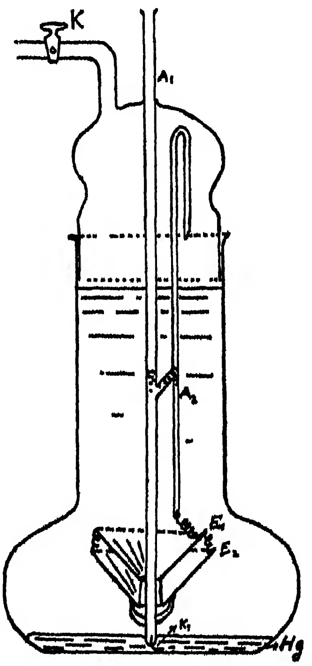
A NEW METHOD FOR PREPARING PURE HYDROGEN.

By V. BAYERLE AND M. TAMELE.

ABSTRACT.

Zinc amalgam does not dissolve in acids on account of a supertension of hydrogen. If, however, a piece of platinum foil, or some other metal capable of reducing the hydrogen obtained by this method, the a rapid evolution of hydrogen from the platinum foil.

This has been made the basis of a new method for making pure hydrogen.



In addition to the absolute purity of hydrogen obtaned by this method, the process also possesses the advantage that the evolution of gas can be made to take place under any pressure.

An automatic regulation of the liberation of gas at a maximal pressure is effected by means of mercury contacts. When this is reached, contact is broken and the evolution of hydrogen stops automatically.

The apparatus can be purchased from F. Zahradnik, Prague II., for about £6.

(Abstracted from *Chemické Listy*, 1925. XVIII., 890.)

Trade and General Notes.

CORNELL UNIVERSITY, NEW YORK.

Generous Gift for Chemical Research.

Cornell University, situated at Ithaca, New York, has received an anonymous gift of $250,000, the income of which it to be used by the University for the benefit and advancement of teaching and research in chemistry and allied fields. The gift is made to enable the University to carry out a plan formulated by Professor L. M. Dennis, head of the Department of Chemistry. Under this plan the University will invite prominent men of science to come to Cornell, each for one or two semesters, to present the most recent advances, and the methods and results of their own investigations, in the branches in which they have won distinction.

The endowment provides for the printing of these lectures, and these publications will undoubtedly form a series of authoritative monographs of distinct and unusual interest and value.

The lectures will be open to Members of the staffs of instruction of sister institutions and they are cordially invited to avail themselves of the opportunity thus afforded to hear the leaders in chemical and physical science.

A private research laboratory will be placed at the disposal of the non-resident lecturers, who will thus be enabled to instruct a limited number of properly qualified students in the methods of outlining and carrying forward investigations in the visitor's special field.

It is planned so to choose the lecturers that different branches of chemistry or of allied sciences will be presented from term to term.

Cornell University is pleased to be able to announce that the first incumbent of this non-resident lectureship in chemistry will be Professor Ernst Cohen, Professor of Physical and Inorganic Chemistry in the van't Hoff Laboratory at the University of Utrecht, Holland. He will be in residence at the University during the second semester from February 1 to June 1, 1926.

To those familiar with modern advances in chemical science, particularly in physical chemstry, professor Cohen needs no introduction. He is the author of many books and pamphlets, comprising lectures and texts in the fields of inorganic and physical chemistry for the use of physicians and biologists, and biographical studies of various distinguished chemists, including his famous predecessor, J. H. van't Hoff.

The original investigations of Professor Cohen and his co-workers cover a wide range of topics along the lines of thermodynamics, thermochemistry, electrochemistry, piezochemistry, and in other branches within the fields of physical and inorganic chemistry. These have been published in the form of some two hundred articles in the leading Dutch, French, German and English scientific periodicals. Among these Professor Cohen's researches upon metastable and allotropic forms of the elements have attracted particularly wide attention.

Professor Cohen is this year President of the International Union of Pure and Applied Chemistry, which will meet in this country in the summer.

CHEMICAL INDUSTRIES IN FRANCE.

Mr. J. R. Cahill, the Commercial Councillor to the British Embassy n Paris, has recently written a most able review of the industries of France. Among various other matters he deals with dyes and various kinds of chemicals which seem to be largely manufactured, and making great progression in the Republic. Referring to this subject, the *Manchester Guardian Commercial* says: -

The prosperity of the heavy chemical industry, which has prevailed in most branches since 1922, was fully maintained in 1924, and there was a striking development in production. One important concern, for instance, increased its output of superphosphates from 870,000 to 885,000 tons and of chemical products from 420,000 to 408,000 tons, or 12 per cent. It also produced 141,000 tons of by-products. Considerable progress was made in its output of sulphuric acid (of which France exported 389,000cwt. in 1924, as against 210,000cwt. in the previous year), sulphate of soda, sulphide of sodium, chlorine, etc. The same firm is also turning its attention to new manufactures, such as chloride and sulphate of barium and chloride of zinc.

The expansion in the French foreign trade in chemical products is indicated by the steady rise in the volume and value of exports; the former amounted in 1924 to

2.1 million tons as against 1.6 million in 1923 and 1.5 million in 1922, while the latter rose from 766 million francs in 1923 to 1,072 millions in 1924. There was also an increase in imports—namely, from 532,000 tons in 1923 to 544,000 tons in 1924, but it was relatively insignificant, and the whole volume of imports was small in comparison with that of exports.

PANAMA CANAL TRAFFIC.

Vessels passing through the Panama Canal in the fiscal year 1924-25 declined to 4,678 from 5,230 in 1923-24. Cargo carried in America bottoms fell off by over 8½ million tons, and represented 54.5 per cent. of the whole, and it is satisfactory to note that cargo carried in British vessels was under 185,000 tons less than in the previous year, and accounted for as much as 24.6 per cent. of the total. Japan was third with 3.9 per cent.

FRENCH CHEMICAL EXPORTS.

The British Commercial Counsellor at Paris states that the expansion in the French foreign trade in chemical products is indicated by the steady rise in the volume and value of exports; the former amounted in 1924 to 2.1 million tons, as against 1.6 million tons in 1923 and 1.5 million tons in 1922, while the latter rose in value from 855 million francs in 1923 to 1,255 million francs in 1924.

During the first six months of the current year the chemical exports amounted to 11,096.7 thousand metric cwts., the principal items including chloride of pottasium, 8,152.5 thousand metric cwts., chloride of sodium, 886.6 cwt. sulphate of magnesia and potassuim; kainit, 154.7 cwts., products obtained directly from the distillation of coal tar, 107.9 cwts., sulphate of copper, sulphate of ammonia, 88.0 cwts. potash and carbonate of potash, 18.7 cwts., oxide of zinc, 14.8 cwts., celluloid, 4.8 cwts., and carbonate of lead, 0.6 thousand cwts.

BRITISH INDUSTRIES FAIR.

CO-OPERATION OF THE POSTMASTER-GENERAL.

The aid of the Postmaster-General has been invoked for the purpose of making the forthcoming British Industries Fair widely known both at home and abroad.

As from December 20, letters, post cards and other postal packets are being post-marked with the words, "Buyers' Opportunity, British Industries Fair, February 15 to 26, London and Birmingham."

The Government, in this and many other ways, is using every possible means to draw the Fair to the attention of the world's buyers to whom over 150,000 personal invitations to attend the Fair are now being dispatched.

TRADE INCREASE AND INVENTIONS.

It is very encouraging for the outlook of better trade to note that the patent applications for 1925 are about 88,000, showing a large increase on 1924, closely approaching the boom year of 1920, which was the highest on record.

Messrs. Rayner and Co., the well-known Chancery Lane Patent Agents, state that while the motor trade has been particularly favoured with new inventions and designs, the record of activity still remains with the youthful industry of wireless.

A marked feature of the year's patents is the attention paid to the subject of Advertising; showing clearly that new ideas are being sought for in this art which is so valuable to the success of modern business. In aircraft also, some notable improvements have occurred, particularly in airship designs, and important commercial developments are bound to ensue in this direction.

Traders and merchants are everywhere securing special trade marks to protect their individual trade, not only in Great Britain but in the Colonies and foreign countries, and these are clear indications of the awakening of British enterprise both at home and abroad.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF ARTS.

January 21, 1925.

Irish Glass, Old and New, By MRS. GRAYDON-STANNUS.

(*Continued from Page 398, December 18, 1925.*)

Now we come to the most discussed and most famous of all Irish glass districts, namely, Waterford. It is a peculiar fact that the name Waterford has become imbedded in the public inmagination to such an extent that very many people on hearing

a reference to Irish glass, say at once, "Oh, you mean Waterford," and are quite surprised to hear that there were other Irish factories as well. It is certain that not more than two or three per cent. of the glass sold as Waterford is genuine, and very little of it is even Irish. But on the other hand, it is none the less certain that very large quantities of the most beautiful glass was made there. It was, in fact, more largely exported than other types, and this in itself is one reason why it has been so extensively faked. There is ample evidence of large and continuous consignments of Waterford glass having been dispatched to such places and countries as New York, Newfoundland, Pennsylvania, Barbados, Maderia and the West Indies, to say nothing of France, Spain, Italy, Holland, and elsewhere, and there is little doubt in my mind that most of the fakes sold in this country come from Holland copies from originals in Dutch possession. The Waterford factories flourished from 1729 to 1852, with an interval from 1750 to 1780, when the principal works were temporarily closed. All kinds of useful and ornamental glass were made at Waterford, though it is probably most justly famous for its candelabra, chandeliers and its boat shaped and turn over or helmet bowls, whilst here again, whole dessert services were produced. It is interesting to note, that in my extensive continental rambles, I have found some of the best specimens of Waterford glass in France. The finest period of manufacture was just after 1780 when the works re-opened, and the glass was then at its best as regard colour. About 1815 a great deal of heavy top cutting was done at Waterford, but after 1820 the glass began to lose its characteristic colour and certainly became much whiter.

Having completed our tour of the factories, I now propose to deal with the characteristics of Irish glass in general as compared with contemporary English productions and foreign and modern fakes of all kinds.

These characteristics can be grouped under the headings of weight, colour, resil-
them in that order, starting with
ence, ring and touch, and we will deal with
"weight."

Irish glass, except for the blown varieties, is unusually heavy, particularly the early specimens, and that feature is one of our greatest aids when deciding the genuineness of a certain piece. The blown glass as often found in decanters, is, on the other hand, extremely light, but we are helped by the knowledge that these blown pieces in Ireland were hardly ever cut, but either engraved or left perfectly plain, as you will see by these marked Cork blown decanters which I have on show. The engraving is very characteristic and it really varies very little on such pieces, which can be readily recognised and placed. If you examine these decanters carefully and memorise the style of engraving, combined with the misty grey colour, you will be able to pick out a Cork decanter from others when next you see a collection. Similar types of foreign manufacture are frequently marred by sand specks, which are very seldom seen in Irish glass, though air bubbles are often taken for sand specks by the uninitiated. It is important to remember that sand specks are quite opaque, while air bubbles, however minute, are transparent, though it may require a magnifying glass to decide the question. However, the chief point to remember is that apart from blown specimens of that type, Irish glass is *heavier* than its competitors.

We now turn to the great question of colour.

All old Irish glass has a peculiar depth of tone, best described as a steel or grey blue, but the early Cork, Waterford and Dublin are particularly distinguishable by this quality. The cause of this grey tone is unknown, but it was probably due to some impurity in the lead used. Countless efforts have since been made to reproduce it but have been entirely unsuccessful. I myself have carried out the most exhaustive experiments and have made pot after pot from the old receipes in my possession, and Mr. Westropp's, but the results, though of intense interest, only produced a clear white glass.

I have also made analyses of several old bits, and manufactured glass in strict accordance therewith, but the result was always the same a clear white glass.

I cannot say I am sorry I failed as no lover of old Irish glass could be pleased to hear that a piece could be made to-day indistinguishable from the old. Having, however, failed in those experiments, I turned my attention to melting down genuine old pieces of very dark colour, and on re-casting these I found that they retained most of their lovely and elusive tone in nearly every case.

I will pass round a piece which has retained its colour splendidly, but it has, of course, all the brightness of new glass, the softening film of time having vanished in the melting pot.

There is very little difference in the tone of early Dublin, early Waterford and early Cork glass ,except that the latter has sometimes, *but not always*, a yellowish tinge which is quite foreign to the other two, and of the three I should say that Dublin glass was darker and heavier.

In my humble opinion a great deal of harm has been and is being done by some people who take every opportunity of stating in print and in conversation that Waterford glass was in reality white and the well-known grey-blue colour is a myth. To this I always say: "Examine marked pieces, visit the Dublin Museum, and go carefully through celebrated collections." There is no doubt that Mr. Westropp, of the Dublin Museum, says Waterford was whiter than other Irish glass. It certainly was after 1820 and at all times was whiter and clearer than Dublin, the early specimens of which are often nearly black. In my opinion a great deal of the fine dark glass attributed to Waterford is in reality Dublin. To illustrate my point I have brought some unique specimens (family pieces), which are known to be Dublin, and if placed on the market to-day would undoubtedly be classified as Waterford.

Surely the safest ground to be on is to examine *marked* pieces of Waterford, which cannot lie. I have here a decanter marked "Penrose, Waterford," which is a lovely colour and very many such pieces have passed through my hands. I think Mr. Westropp's opinion is largely based on a letter written in 1882 by Elizabeth Walpole to an Englishman named Eardley, who has stated that *all* the Irish glass he had ever seen was dark coloured. Mrs. Walpole says she is sending him some Waterford, "so that he can see for himself," which presumably means, see for himself that he was mistaken. Now, that letter was written in 1882, and there is no doubt that at that date, Waterford glass *was* much whiter. But this letter absolutely proves Irish glass was much darker than English. I believe all glass makers were even then, as now, striving to achieve a clear crystal-like glass, which is really what we mean when we talk of "white" glass. But, it should be borne in mind, that the Penrose period was in the 1780's, and that is the time when the finest pieces of Waterford were made.

A few years ago I had the privilege of examining the collection of Waterford glass in Mr. Penrose's possession, which originally belonged to his grandfather, who owned the glasshouse there. It was quite an education, and what struck one very forcibly was the colour of these beautiful pieces, which greatly resembled old Rose paste.

We will now turn to the question of resilience.

There is no doubt that Irish glass is tougher, stronger and more flexible than English; hence its wonderful survival. It takes a severe blow to break it or even chip it, and I have dropped pieces on the floor, before now, which have not suffered in any way as a consequence.

With regard to the question of the touch or feel of Irish glass, we find that it is never harsh or cold, but has a definite warmth and softness, quite its own. But it naturally requires great experience before such a test can be applied with any degree of accuracy in cases where both specimens of glass being tested are of similar quality and age, one being English and one Irish. The best simile I can give you is the difference between hard paste and soft paste in china.

We now come to the ring or sound produced on striking an Irish bowl. As compared with English glass it has a distinct note of its own, which, perhaps, is more accurately described as a vibration between two or three tones which is given forth with a throbbing effect. The ring of English glass is best described as being clearer, brighter, and sharper; this test can be proved by striking any piece so shaped that it will ring, but naturally no one would expect a salt cellar or a very thick piece of metal to answer to this treatment.

No paper on this subject would be complete without some reference to the cutting of Irish glass. Speaking generally, we can say that the older the glass the softer and lighter the cutting. Heavily cut pieces are of latish date and I have never found an early piece with hobnail cutting on it.

FARADAY SOCIETY.

An Improved Form of Electric Vacuum Furnace, by PROFESSOR J. R. PARTINGTON, M.B.E., D.Sc., AND N. L. ANFILOGOFF, B.Sc., A.I.C.

Read before the Faraday Society on Monday, November 16, 1925.

ABSTRACT.

During the course of research upon some high temperature reactions, we examined the literature for an electric vacuum furnace which would satisfy the conditions we wished to employ, and came to the conclusion that the Otto Ruff type of furnace appeared to be the most suitable. It is upon this type we have modelled the furnace now described. On close examination of Ruff's published drawings,[1] however, we found that the erection of the furnace from these and the descriptions given with them was almost impossible. We further consider that the raising of the Ruff hot-tube, as shown, to a high temperature could have no other result than to cause the tube quickly to fracture, since it appeared that proper support, and the tube itself could not carry the weight of the upper portion whilst at high temperatures. We were thus compelled either completely to design a furnace for ourselves, or so to improve the design of Ruff's furnace as to enable us to overcome its mechanical and electrical deficiencies. The lattes course was at first adopted, and since in our further investigations we have improved upon the shortcomings in our own initial design, the final furnace is, we believe, the most satisfactory vacuum furnace of this type for work at high temperatures which has been described.

Having been able to work under vacuum at temperatures approaching the volatilisation temperature of carbon we considered it useful to submit at the present stage a complete set of working drawings which should save anyone requiring some such furnace the difficulties which we have ourselves encountered, and enable him, by closely following the drawings and specification, to erect one with the least trouble and expense.

The furnace is designed for studying reactions at high temperatures, the reacting substances, if solids, being contained in a graphite crucible turned from the same material as the hot tube and maintainable either in a high vacuum or in an atmosphere of an inert or reacting gas. The issuing gas is capable of analysis if the vacuum lead from the furnace to the pump has a T-piece connecting to some sort of gas holder, a pipe from the latter being either connected straight to the pump or, by means of another T-piece, to the original vacuum lead to the pump, but nearer the pump than the first T-piece, the intermediate piping containing a cock. Thus, having passed the gas to the pump for a time, to ensure uniformity, the issuing gas may then be diverted through the holder and a quantity collected. If necessary, the gas pressure in the holder may be brought to atmospheric pressure by allowing a gas unlikely to affect the results of the analysis to enter.

GEOLOGICAL SOCIETY OF LONDON.

Dr. W. J. Evans, F.R.S., presided at the meeting on December 2.

The following communication was read:

The Depth of Origin of Earthquakes, by RICHARD DIXON OLDHAM, F.R.S., F.G.S.

ABSTRACT.

Methods of determing the depth of origin of an earthquake, dependent on observations of the time of occurrence, demand records of a degree of precision, and in numbers, which are seldom available. The same objection applies to the Dutton method, based on variation in the intensity of shock; but the method is capable of a simplification which will make it applicable to any case where the area affected by the sensible shock, and the maximum degree of violence attained, can be determined. The original method has been examined, and it is shown that, although the method is sound in principle, two important errors have been introduced in the application. Acceleration has been taken as the measure of intensity, whereas the formula demands that the product of maximum acceleration and amplitude of displacement should be used; and the effect of absorption of energy in transmission has been treated as negligible. It is shown that either of the errors so introduced woud be material, but, being opposite in sign and about equal in amount, they nearly neutralise each other, with the result that the depth obtained is approximately correct. The simplified method is applied to the discussion of the Italian record for the years 1897-1919, comprising 5,605 distinct shocks; it is found that more than 90 per cent. of these originated at

depths of less that 10 km., and mostly round about 5 km.; while only 1 per cent. originated at depths exceeding 80 km. This is in strong contrast with the depths of origin of the distant records, which have been computed by different workers at figures ranging from 50 km., in a few cases, to, in most cases, 100 km. or more. From this it is concluded that the ordinary local earthquake, which can be felt, differs from that which gives rse to distant records, not merely in magnitude, but also in character of cause and origin; in those cases where distant records accompany a destructive earthquake, the disturbance has a twofold origin, the episeism, or surface-shock, by which the damage is directly caused, being a secondary result of the bathyseism, which is the origin of the distant record. The great tumber of local shocks are purely episeisms, without any recognisable bathyseism; in rare instances the sensible shock appears to have originated directly from the bathyseism, unaccompanied by any recognisable episeism.

Discussion.

The president suggested that the density of the surface-rick must be taken into account, in addition to the amplitude and acceleration, in estimating the energy of earthquake vibrations. Vibrations with a given amount of energy, emerging where there was a dense surface-rock, would produce less movement than vibrations of the same energy emerging where the surface was composed of less dense material.

Professor W. J. Sollas also spoke.

The author acknowledged the remarks of Professor Sollas and the president, and, in reply to the latter, said that the violence of shock certainly varied considerably with the nature of the subsoil; two adjoining localities might experience a very different degree of intensity of shock, as expressed by one of the scales in use, although the intensity in the sense used in the formula would presumably be much the same at both; but, when these local variations were averaged out, both intensity and violence decreased steadily with increasing distance from the epicentre.

Stone axes and other stone implements, and topaz chips, tin beads, etc., from Nigeria were exhibited on behalf of Major E. W. Byrde, F.G.S.

Stone implements and sand from Northern Nigeria were exhibited on behalf of H. Preston, F.G.S., chairman of the Grantham Museum Committee.

Ferruginous concretions, found by Major E. W. Byrde in alluvial workings on the Nigerian tinfield, were exhibited by Dr. J. D. Faconer, M.A., F.G.S.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

The monthly Council Meeting was held at the offices, 16, Bedford Square, London, on December 9.

Mr. Luddington (chairman) reported that the consulting chemist had submitted a list of samples analysed by him for members during the month of November. The Committee had considered the annual report for 1925 of the consulting chemist. This, with certain amendments, had been passed for publcation in the journal. Dr. Voelcker had made reference to the Agricultural Conference recently held at Rothamsted. It had been suggested by a member of the Committee that it would be advantages if a *résumé* of the proceedings at such conferences could be included in *Occasional Notes*, or other publication. The consulting chemist had reported that a further conference of scientists had been called by the Ministry of Agriculture to consider the question of unexhausted manurial values. For the ensuing year the Committee estimated that their expenditure will amount to 400, plus the amount of the laboratory petty cash, about £20. During the year the Committee had met eight times and made eight reports.

NOTICES OF BOOKS.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry, by J. W. Mellor, D.Sc. Vol. VI. X + 1024 pp. with 221 Diagrams. Price £3 3s. net. Longmans, Green and Co., 39, Paternoster Row, London, E.C.4.

This is a valuable work, and dealing as it does comprehensively with the various silicatesThe work, however, is not by any means confined to the silicates, wide as is the list of minerals connected both directly and indirectly therewith. The History of Carbon Dioxide is continued : its occurence, the metabolism of animals and plants, the formation and preparation of carbon dioxide, its physical properties, its solubility, chemical properties, are fully explained, while suitable diagrams and pages

of references are given. 130 pages are devoted to carbon. Silicon is, however, the main subject of the book, and the author opens up references to Greek and other ancient philosophers. He claims that next to oxygen, silicon is the most important element in nature, occurring as it does in all important rocks outside the carbonates. An important feature of the volume is that the references are interpolated in the body of the work, following the appropriate sections. Very naturally, the index is exhaustive, which is a feature of importance in a work of such magnitude, and one which will prove a valuable addition to any scientific library.

Les Méthodes Physiques Appliquées à la Chimie, par P. JOB. Pp. 260. Paris: G. Doin. 1926. Price 30 francs.

The author of this book has set out to create a greater appreciation on the part of chemists of the application of physical methods in general laboratory procedure.

He reviews some of the problems that beset the experimentalist. These include the identification and degree of purity of bodies; the determination of constants, e.g., atomic and molecular weights; and the composition of organic compounds and of minerals. In connection with each of these the author indicates the manner of attack along physical and physico-chemical lines. Most of his methods are well recognised and are regularly practised by many chemists, although it can well be maintained that an extension of these methods would be attended with success.

An important new process for establishing the purity of a salt has escaped the attention of the author, and which it is to be hoped will find its way into the next edition. The dropping mercury cathode method (with polarographic attachment) was described by Heyrovsky in the May issue of the *Recueil des Travaux Chimiques des Pays-Bas*, and should receive wide applications in the future. Prof. Heyrovsky has already turned it to good account in finding a slight trace of impurity in "pure" manganese sulphate. This turned out to be due to the element dvi manganese (*Nature*, 1925, November 28; see also Loring and Druce, *The Chemical News*, this volume, pp. 273, 336).

Coming back to the book under review, it may be mentioned that the examples chosen to illustrate the applications of physics to practical chemistry are carefully explained without being burdened with tedious and superfluous details.

The book is well worthy of an English translation.

J. G. F. D.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Thursday, January 14, at 4.30 p.m.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London (Dominion and Colonies Section), Tuesday, January 5, at 4.30. Lecture by Henry D. Dartray, C.B.E., "France in North Africa."

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W.1.

Sir William Bragg, F.R.S., etc., will deliver a series of six lectures (for juveniles) at 3 p.m. on Tuesday, December 29, "The Trade of the Sailor"; Thursday, December 31, "The Trade of the Smith"; Saturday, January 2, 1926 "The Trade of the Weaver"; Tuesday, January 5, "The Trade of the Dyer"; Thursday, January 7, "The Trade of the Potter"; and Saturday, January 9, "The Trade of the Miner."

INSTITUTE OF ELECTRICAL ENGINEERS.

January 7, at 6 p.m., Captain Eckersley, "Past, Present and Future Development in Wireless Telephony."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

30,727.—Beck, C. W.—Apparatus for manufacture of alkali sulphates and hydrochloric acid. December 5th.

30,364.- Esselmann, P. Purification of carbon disulphide. December 1st.

30,759. May and Baker, Ltd. Manufacture of basic bismuth salts of arylarsinic acids. December 5th.

30,792. Riedel Akt-Ges. J. D., Manufacture of barbituric-acid derivatives. December 5th.

Specifications Published.

243,046. Liebreich, E. -Production of solutions containing oxides of chromium, and the electrolytic separation of chromium from such solutions.

248,104. Kersten, Dr. J. Process and apparatus for the decomposition of the alkali chlorides by steam in the presence of silicates.

248,122. Humphrey, H. A., and Synthetic Ammonia and Nitrates, Ltd. Production of mixtures of nitrogen and hydrogen for ammonia synthesis.

224,522. Farbwerke Vorm. Meister, Lucius and Brunning. Manufacture of Bz-2′-oxybenzanthrone.

Abstract Published.

241,829. White lead. Lloyd, G. F., Coronation Street, Brighton, and Campbell, F. H., 85, William Street, Melbourne, both in Victoria, Australia.

White lead is prepared by reacting on a highly basic sulphate of lead with an aqueous solution of a bicarbonate of an alkali metal which may contain undissolved carbonate. The basic sulphate is prepared by the action of concentrated sulphuric acid on lead monoxide in the presence of a small quantity of another acid, such as acetic or nitric acid, to ensure the presence of some lead in water soluble form, the mixture being ground during the process. Acid sulphates of alkali metals, such as sodium or potassium may be substituted for the sulphuric acid. The temperature during sulphating should be maintained at about 40° C., by blowing in steam and should not exceed 50° C. The proportion of water during sulphating should be between ½ and 2 parts for each one part of the oxide. The final product is washed and dried or mixed with oil and ground. Figures are given of the various quantities used.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

STATOPHONE.

460,363. Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives. Tri-Ergon Aktiengesellschaft, Tienhofe 7, Zurich Switzerland. December 9th, 1925.

EFFICYL.

462,661. Chemical substances used in manufactures, photography or philosophical research and anti-corrosives, but not including compositions for the prevention and incrustation in steam boilers, or goods of a like kind. - Badische Anilin and Soda Fabrik, Friesenheimerstrasse, Ludwigshafen-on-Rhine, Germany. December 9th, 1925.

Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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By the REV. J. E. ROSCOE, M.A.

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Various numbers, parts of Vols 117 and 118 (1918/19) are only on sale at 2s. 6d. each

THE GENERAL INDEX TO VOLS. 1 to 100 can still be purchased at £1 1s. (CARRIAGE PAID.)

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